Aviation Week & Space Technology

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September 3, 1962

Carpenter Reports On MA-7 Flight

XC-142 VTOL Mockup

SPECIAL REPORT:

Titan 2 Under Conversion to Gemini Booster

Tomorrow s spacecraft will need highly sophisticated reaction control systems to perform complex maneuvers— randezvous planetary landings re entry, course correction, and orbital stabilization To meet this need, the Space Propulsion D vision of Aerojet General s Liquid Rocket Plant is carrying out extensive research and development on attitude control. Now in development bipropellant systems using storables or cryogenics— storable propellant pulse rockets with ½ to 500 pounds thrust, capable of being operated continuously or pulsed at intervals as short as 20 milliseconds with good repeatability ablative and radiation cooled chambers valves and components cycled repeatedly up to 1 000 000 times under 10^{-9} Hg and positive-expulsion light-weight tankage LIQUID ROCKET PLANT, Sacramento, California

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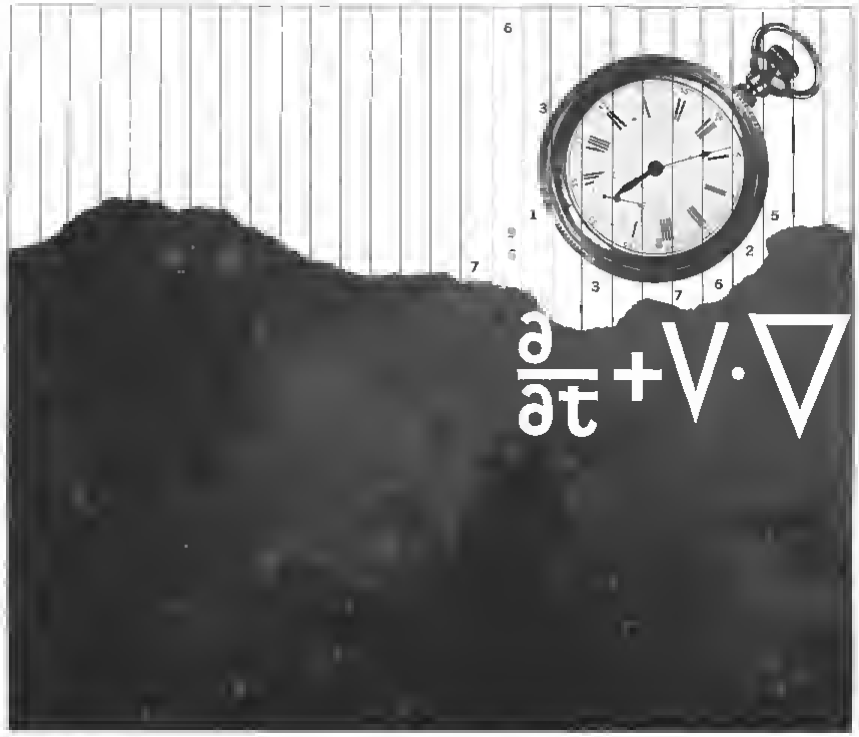

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AEROSPACE CALENDAR

Sept. 10-14—Fourth National Conference on Applied Meteorology, American Meteorological Society, Hampton, Va.

Sept. 10-14—Annual General Meeting, International Air Transport Assn., Dublin

Sept. 13-14—10th Annual Engineering Management Conference, IRE, Hotel Roosevelt, New Orleans, La.

Sept. 17-18—Hydrofoil & Air Cushion Vehicles Meeting, Institute of the Aerospace Sciences, Shoreham Hotel, Washington

Sept. 18-20—Ordnance Environmental Research Symposium, El Tropicano Hotel, San Antonio, Tex. Sponsor: Environmental Research Office of the Office of the Chief of Ordnance. Arranged by Southwest Research Institute

Sept. 18-23—16th National Convention & Aerospace Panorama, Air Force Assn., Las Vegas, Nev.

Sept. 19-20—Technical Manpower Utilization Meeting, Institute of the Aerospace Sciences, Hotel Commodore, New York

Sept. 19-20—Operations & Maintenance Symposium, Arwork Corp., Millville, N. J.

Sept. 19-20—11th Annual Industrial Electronics Symposium, Sheraton Hotel, Chicago, Ill. Sponsors: IRE, American Institute of Electrical Engineers; Instrument Society of America

Sept. 19-21—Sixth National Conference on Tube Techniques, Western Union Auditorium, New York, N. Y. Sponsor: Advisory Group on Electron Devices

Sept. 19-22—Second International Agricul

(Continued on page 7)

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AEROSPACE CALENDAR

(Continued from page 5)

tural Aviation Congress, National Superior Agronomy School, Grignon, France

Sept. 24-28—13th International Astronautical Congress, American Rocket Society, Sofia, Bulgaria

Sept. 24-Oct. 12—International Air Transport Assn. Traffic Conferences, San Marcos Hotel, Chandler, Ariz.

Sept. 25-26—Conference: Navy Microelectronics Research & Development, Department of Interior Auditorium, Washington, D. C. Sponsor: Office of Naval Research

Sept. 25-27—Third Annual Symposium on Helicopter Open Sea Rescue, Kaman Aircraft Corp., Bloomfield, Conn. Sponsor: Naval Air Material Center, Air Crew Equipment Laboratory

Sept. 25-26—Space Power Systems Conference, American Rocket Society, Miramar Hotel, Santa Monica, Calif.

Sept. 26-27—Symposium on the Physics of Failure in Electronics, Illinois Institute of Technology, Chicago, Ill. Co-sponsors: Rome Air Development Center, USAF Systems Command, Armour Research Foundation

Sept. 26-Oct. 2—1962 General Conference, Federation Aeronautique Internationale, Athens, Greece

Sept. 27-28—Symposium on Dynamic Behavior of Materials, University of New Mexico, Albuquerque, N. M. Sponsors: University of New Mexico; American Society for Testing and Materials

Sept. 27-28—Symposium on the Dynamic Behavior of Materials, American Society for Testing and Materials, University of New Mexico, Albuquerque, N. M.

Sept. 28-29—Society of Experimental Test Pilots' Sixth Annual Awards Banquet & Symposium, Beverly Hilton Hotel, Beverly Hills, Calif.

Sept. 30—Third Annual Aerospace Fair, Vandenberg AFB, Calif. Open to the public 10:00 a.m.-4:00 p.m.

Oct. 1-3—Seventh Annual Exposition & Symposium, Air Traffic Control Assn., Flamingo Hotel, Las Vegas, Nev.

Oct. 1-3—National Communications Symposium, Institute of Radio Engineers, Hotel Utica, Utica, N. Y.

Oct. 2-4—Symposium on Physics and Nondestructive Testing, Granada Hotel, San Antonio, Tex. Arranged by Southwest Research Institute

Oct. 2-4—Third Symposium on Advanced Propulsion Concepts, Cincinnati, Ohio. Co-sponsors: AFOSR, General Electric

Oct. 2-4—National Symposium on Space Electronics and Telemetry, Institute of Radio Engineers, Fontainebleau Hotel, Miami Beach, Fla.

Oct. 2-4—15th Annual Meeting and Convention, National Business Aircraft Assn., Penn-Sheraton Hotel, Pittsburgh, Pa.

Oct. 18-19—Second National Conference on Planning & Designing Urban Heliport Facilities, Institute of Aerospace Sciences Bldg., Los Angeles, Calif. Sponsor: Los Angeles Chamber of Commerce

Nov. 13-18—17th Annual Meeting and Space Flight Exposition, American Rocket Society, Pan Pacific Auditorium, Los Angeles, Calif.

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$240-Million Deficit Foreseen by NASA — 16
▶ Expansion of lunar program, troubles with Centaur are forcing reprograming or supplemental request.

Shield Sought For Vertol Engine Intake — 28
▶ Parts ingestion causes engine failure in New York and Japan; New York Airways alters overland route.

Titan 2 to Have Manned Flight Boost Capability — 38
▶ Simple design, redundant malfunction detectors, painstaking manufacturing process to allow Gemini launch capability.

COVER: First photo of the full-scale mockup of the Vought-Hiller-Ryan XC-142 tri-service V/STOL transport shows the aircraft's wings tilted in a position duplicating vertical takeoff and landing configuration. Formal inspection of the mockup was conducted recently by a board of Air Force, Navy and Army officials at Ling-Temco-Vought's Grand Prairie, Tex., facility. Five prototypes will be built there—three for investigation by the services of procedures and techniques associated with V/STOL operational vehicles in the 1965-1970 period. For additional photos and data see p. 24.

PICTURE CREDITS

Cover—Art Schoenr, Ling-Temco-Vought; 19—Jet Propulsion Laboratory; 21—Harding Aircraft; 23—Grumman Aircraft Engineering Corp.; 25—Ling-Temco-Vought; 28, 51—Wide World; 38, 41—Martin Co.; 55—Republic Aircraft Corp.; 46—USAF; 55—NASA; 59, 63—Jet Propulsion Laboratory; 65—Electric Radiation; 68, 69, 73—Aerojet General Corp.; 81—Hercules Powder Co.; 82—Lamtex Industries Inc.; 83—Lycoming Div., Avco Corp.

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EDITORIAL

Mach 2 Off the Deck

When the post war jet age dawned in military aviation there were skeptics, many of them in the Navy, who doubted if carrier based aircraft could make the transition to the really high performance offered by supersonic aerodynamics and jet power ranges. As a result of these doubts naval aviation lagged badly during the pre-Korean period. When swept wing transonic fighters were required to match the MiG 15 in Asia, the Navy had none of its own and hastily had to convert the USAF North American F-86 design to carrier use.

Now the Navy has a stable of carrier based aircraft that perform in the Mach 2 speed range and are the performance equals of any first line operational aircraft flying under any flag in the world today. In the past year we have had an opportunity to observe this new generation of carrier based aircraft operating from modern carriers such as the USS Forrestal in the Mediterranean and the new nuclear powered USS Enterprise during her initial shakedown in the Atlantic and it is truly a sight we had never expected to see. This new vitality that has once again made naval aviation a first class fighting force is due to three factors:

- **Leaders of naval aviation** who never abandoned their faith that carrier based aviation could continue to grow with the tremendous advances in aerodynamics and power.
- **Three British-developed techniques** that converted the carrier deck into a suitable airfield for supersonic, high gross weight aircraft.
- **Three Mach 2 plus aircraft** types designed specifically to combine high performance with the advantages of the new carrier deck—the Vought F8U Crusader, the McDonnell F4H Phantom and the North American A3J Vigilante.

Without the British developed contributions to carrier design, supersonic airplanes would never have operated from a ship's deck.

The steam catapult makes it possible to give the high gross weight supersonic jets their initial fast acceleration before the jet power can truly take over.

The angled or canted deck not only removes the vulnerable parked deck load of planes as a target for planes overrunning the arresting gear or overshooting the deck, but it also permits much higher approach and wave-off speeds to add appreciably to the safety margin of jet operations.

The mirror landing system provides a visual glide path that makes possible a uniform precision of approach for each aircraft type in its best pattern. This is far more reliable than the visual and voice signals of the landing signal officer, although he still has an important function during this critical phase.

Another important operational aid is aerial refueling with probe and drogue "buddy system" equipment. The quick convertibility of carrier based aircraft from tactical to tanker aircraft with this equipment provides far greater combat flexibility in extending range and striking power of a portion of the carrier air groups and also eliminates the hazard of running out of fuel during the variety of delays that can complicate carrier recovery. At least one tanker aircraft is kept aloft in the carrier's vicinity during all recovery operations to refuel any returning plane that is low on fuel or any planes that may have to stand by before recovery for longer periods due to a fouled deck or other emergencies.

But one familiar sight that still greets the seasoned observer of carrier operations during the post war period is the squat, sturdy profile of the Douglas AD Skyraider, the piston powered workhorse of carrier aviation for over 15 years and battle scarred veteran of the Korean war. The AD series has gone into so many dash numbers and modifications for all kinds of special purposes that only an expert could readily catalogue them. But among carrier based pilots who have the ultimate responsibility for delivering a nuclear weapon onto a distant target, many of them still prefer this lumbering Skyraider, with its ability to hug the terrain below radar coverage and a range that permits a wide variety of target approaches.

Carrier based Skyraider pilots in the Atlantic regularly penetrate far inland to major U. S. cities at minimum altitudes without detection by the land-based air defense system. When the Grumman A2F jet powered, missile-launching attack planes begin to replace the venerable Skyraider at sea next year, many pilots will be sorry to see the AD phase out of the inventory. This veteran certainly deserves a niche in the air museum as well as a chapter in the history of military aviation.

But ships and aircraft are only two of the vital ingredients that compose Mach 2 naval aviation. Without the proper men, neither of them would be worth much. It is the men of naval aviation in its Mach 2 era that really make it function. From the hard-headed admirals who fought their ideas through to reality to the air bosses, pilots, maintenance men and flight deck crews, the men have mastered the complexities posed by the speed and precision of supersonic performance.

From the concrete sterility of the Pentagon, the importance of trained and enthusiastic manpower is too often neglected, partly because it is difficult to measure in graphs, charts and statistics and partly because it is difficult for people who have never been in combat to realize how large a factor it is in the ultimate decision of victory or defeat.

If you watch the lightning-paced ballet of a modern carrier's flight deck during the launching and recovery of Mach 2 aircraft, you cannot help but develop a better appreciation of how the whole complex of machinery is helpless without the lubricant of properly trained and motivated manpower.

If and when the Secretary of Defense ever gives a green light for the development of the USAF Navy TFX tactical fighter, carrier based aviation will take another large technical step forward that will keep it fully abreast of its land-based competitors. In an age when this nation faces the threat of both large scale atomic war and limited wars with conventional weapons in remote areas of the globe, naval aviation in its most modern form will continue to play an important role. —Robert Hotz

WHO'S WHERE

In the Front Office

Edwin L. Farmer, formerly controller of General Dynamics/Fort Worth, now vice president of finance for Textron's Bell Helicopter Co., Fort Worth, Tex.

James V. Bitner, Jr., vice president, Instrument Division, Lear Siegler, Inc., Grand Rapids, Mich. Also named vice presidents **Russell W. Richardson** for contracts, **Johannes N. Thury** for engineering, **Robert A. Gollhardt** for manufacturing.

George A. Banno, president, ITT Kellogg Communications Systems Division, Chicago, Ill.

Nevin Palley, former executive vice president of Curtiss-Wright Corp., appointed executive director of technical operations for Martin Co.'s Denver Division.

John P. Maguire, Jr., secretary, General Dynamics Corp., New York, N.Y.

Lt. Gen. Donald N. Yates (USAF, ret.), a vice president, Raytheon Co., Lexington, Mass., and general manager of the company's Missile and Space Division. Gen. Yates commanded the Air Force Missile Test Center at Cape Canaveral from July, 1954, to May, 1960.

Brig. Gen. Richard M. Hurst, Deputy Commanding General, Ballistic Missiles, U.S. Army Missile Command, Redstone Arsenal, Ala., will retire Sept. 30.

Honors and Elections

Gen. B. A. Schriever has presented Distinguished Service Medals to **Lt. Gen. Thomas P. Gerrity** (AW June 4, p. 37) and **Maj. Gen. Osmond J. Ritland** (AW June 25, p. 35) for "outstanding achievements in furthering the aerospace capabilities of the United States in ballistic missile and space programs."

Changes

Dr. Paul R. Fuller, chief, Behavior Systems Section, Life Sciences Department, Martin Co.'s Space Systems Division, Baltimore, Md.

C. B. Bunch, manager, Air Force Programs for the Garrett Corp. with offices in Dayton, Ohio. **Russ Smith** succeeds Mr. Bunch as manager, Dayton office.

Charles L. Greenslit, assistant manager, Government Products Group, the Bendix Corp.'s Radio Division, Baltimore, Md. Other divisional appointments: **Charles G. McMullen,** chief scientist, **E. Crogan Shelor, Jr.,** manager of a new advanced product development group.

General Dynamics/Astronautics, San Diego, Calif., has appointed the following assistant program directors for the Atlas weapon system project: **P. J. Lynch,** weapon system support program office; **W. F. Miller,** weapon system development program office; **Ernie Wade,** Nike-Zeus program office. Other appointments: **J. M. Rogers,** manager, activation and support; **E. R. McFadden,** manager, systems engineering; **C. J. Dunn,** chief engineer-design; **F. E. Grossher,** manager, manufacturing operations; **G. E. Furness,** manager, program control; **D. L. Fagan,** manager, test and launch operations.

INDUSTRY OBSERVER

► **Army is developing a requirement for a company support VTOL transport whose 200-kt. speed and 10-ton payload specifications point toward a compound helicopter. Army is considering existing hardware, such as the Fairey Rotodyne that was canceled by the British, and new developments.**

► Air Force Space Systems Division has again changed the code designations of its major space programs. SSD has now replaced the numerical codes—substituted earlier this year for popular names (AW July 16, p. 33)—with an entirely new group of numbers. Thus, the Midas missile defense alarm system, until two weeks ago called 239A, is now 461. The satellite inspector, popularly known as Saint, has had its short-lived designation of 621A changed to 706. Similarly, Vela Hotel will be called 823 instead of 698AM.

► **Target date for launch of National Aeronautics and Space Administration's Project Relay communication satellite has slipped several months and presently is planned for November at the earliest. Radio Corp. of America is the Relay satellite contractor.**

► Army Engineer Research and Development Laboratories plans a research program to determine if the presence of an anti-tank mine field can be detected from analysis of aerial photographs. Detection would be based on the field's effects on the wavelength of infrared radiation from vegetation growing above the mines. Interested companies must contact the Army by Sept. 24.

► **Test of the practicality of using a passive satellite in transmitting business data is being considered by Collins Radio Co. technicians. They plan to use the next Echo balloon in an experiment to pass payroll data between the company's plants in Cedar Rapids, Iowa, and Dallas, Tex.**

► National Aeronautics and Space Administration now says the Telstar satellite was not affected in any way by the new radiation belt formed after the recent high-altitude nuclear explosion. The agency earlier said the solar cells were slightly degraded by the new belt (AW Aug. 27, p. 32). Bell System and NASA now plan to launch a second Telstar during the last quarter of 1962.

► **North American Aviation's Space and Information Systems Division briefed industry Aug. 23 about the 21-man space station it has been studying (AW Apr. 16, p. 75) for National Aeronautics and Space Administration. North American asked industry for proposals on various technical elements of the space station system, from which it will select its team members for an impending NASA requirement.**

► First firing of a Boeing Minuteman ICBM from USAF's Vandenberg AFB, Calif., is expected within the next month.

► **Under Advanced Research Projects Agency's Hardpoint program (AW Aug. 27, p. 32)—a study of an active defense of ICBM sites—American Machine & Foundry will investigate all aspects of hardened construction of the system's radar, radar pedestals and anti-missile missiles. Hughes Aircraft will have responsibility for radars and the anti-missile missile, while Maxson Electronics probably will handle antennas.**

► Aerojet-General Corp. was expected to run a 200-sec. test firing last week of Engine AJ10-137, one of the type to be used in the Apollo service module propulsion system (AW July 16, p. 38).

► **Two new long-range versions of the de Havilland Trident three-jet transport (AW July 23, p. 27) will incorporate fuselage center section fuel tanks and leading edge slats, replacing present drooping leading edge. Both versions include uprated Rolls-Royce Spey RB 163-2W engines and an increase to 128,000 lb. gross weight. Trident 1E wingspan will be increased by 5 ft. and fuselage length of the Trident 1F will be stretched 110 in. to provide a seat total of 125 in economy class, compared with 108 for the Trident 1E.**

Washington Roundup

Defense Dollar Impact

Congress is frankly looking at defense spending as an economic tool to be used where it is needed most. The extension of this view results in the award of contracts more than ever on the basis of company and area need rather than technical ability. A recent forum for this and opposite views was the Senate Small Business Committee. Chairman Hubert H. Humphrey held a hearing last week designed to find out whether the Defense Department was channeling enough money to needy areas of the U.S. "One of the most powerful economic tools can be the defense budget," he said.

The Democratic leader is from Minnesota, one of the states feeling the pinch of the increasing shift of defense and space dollars away from the Midwest to the Southeast and West Coast. In discussions with Kennedy Administration leaders, lawmakers have argued with some success that defense and space dollars must be spread over a wider area, even if this means skipping over the best technical proposal at times. In one recent competition, proposals were reevaluated three times until the only Midwestern contractor among the finalists made it to the top of the list. Pressure to award contracts this way will be especially heavy between now and the November elections.

Soviet Space Program

Sen. Alexander Wiley, ranking Republican on both the Senate foreign relations and space committees, last week wrote Chairman Richard Russell of the Senate Armed Services Committee that hearings should be held to evaluate "the real military potential" of the Soviet man-in-space program. But no one in Congress—including Sen. Wiley—really expects that such hearings will be started this late in the session.

Sen. Howard Cannon, Nevada Democrat who recently criticized the Kennedy Administration for not placing more emphasis on the military's space activities (AW Aug. 20, p. 31), has now swung his attention back to space manpower.

"We can know our reserves of raw material down to a goat's hair," Sen. Cannon said last week, "but when it comes to priceless engineering and scientific talent we have only the foggiest notion as to where these people are or what they are doing." He said it was high time the government conducted a census of such talent.

Cuban Military Buildup

President Kennedy said the U.S. has no information "as yet" that any anti-aircraft missiles have been shipped to Cuba by Iron Curtain countries. State Department said it has no evidence to confirm reports that space tracking sites or missile emplacements are being built. Pentagon is satisfied that it is abreast of the military buildup in Cuba, but information coming out of the island on the political situation continues to be confusing.

The President is expected to appoint incorporators soon for a Communications Satellite Corp. to develop and operate the industry-government system. The incorporators will serve as the initial board of directors. The permanent board will consist of six directors elected by holders of public stock, six elected by holders of communications common carrier stock and three appointed by the President.

The House accepted all Senate amendments to legislation authorizing establishment of the corporation by a 372 to 10 vote and the President signed the bill into law last week.

Atomic Energy Commission is developing a detailed five-year program, following the example of Defense Department. It will be extended as a generalized program to 10 years, according to AEC Chairman Glenn T. Seaborg. The objective is to enable AEC to direct its current work with long-term objectives fully in mind.

New Job for Slayton

Astronaut Donald K. Slayton, who was disqualified from Mercury flights because of a heart flutter, will become technical assistant to Walter C. Williams, associate director and operations chief of NASA's Manned Spacecraft Center in Houston, Tex.

Meanwhile, NASA expects to select its next group of astronaut candidates within two weeks, but has not yet decided on the final number. In any event, those selected will be told they are candidates, and not astronauts. Mercury pilots were virtually assured at the time they were selected that they would fly space missions.

University of North Carolina has granted Prof. George Simpson, sociologist, author and industrial organizer, a two-year leave of absence for his move to National Aeronautics and Space Administration, where he is serving as assistant administrator for public affairs at $20,000 a year. According to a university publication, "Developing regional cooperative and decentralized projects will be one of Dr. Simpson's duties in the mainstream of the nation's space program."

Defense secrecy policies prohibit companies involved in nuclear submarine and missile development work from identifying the Ethan Allen as the sub that launched a Polaris for a warhead test in the Pacific in Operation Dominic, even though the sub went through the Panama Canal.

—Washington Staff

$240-Million Deficit Foreseen by NASA

Expansion of lunar program, troubles with Centaur are forcing reprograming or supplemental request.

By Edward H. Kolcum

Washington—Expansion of the manned lunar landing program and faults in the Centaur hydrogen-fueled rocket stage are forcing National Aeronautics and Space Administration to seek at least $240 million more in Fiscal 1963 funds—by reprograming, by asking Congress for supplemental funds, or both.

Chances are that the agency will be unable to find enough money to support the expanded Apollo project and will request a supplemental appropriation soon after the first of next year. A number of studies initiated since NASA made a decision to use lunar rendezvous for a manned landing on the moon will be completed later this year, and the agency will decide then which other programs will be deferred to provide funds for:

- Lunar landing vehicle.
- Lunar logistics system.
- Saturn C-1B vehicle.

NASA may face a more formidable task in getting through the Budget Bureau with its request for more funds than it will in getting Congress to approve more money. In his message to the nation last Aug. 13 on the state of the U. S. economy, President Kennedy said no increases in expenditures were planned beyond those already submitted to Congress. But he added that he wants "to make it clear that we will have no hesitancy in doing whatever must be done to meet our obligations to the nation."

NASA has informed Congress that there will be some deficits in the space program, mainly in manned space flight, but the specific areas of deficit cannot be identified until after the studies now under way are completed.

Program expected to lose most money to these new projects is the Nova launch vehicle, for which NASA requested $163.6 million in Fiscal 1963. However, hardware development for the Apollo program will cost at least $200 million more than was requested by NASA.

NASA already has announced Nova development will be deferred two years (AW July 16, p. 32), but how this will be translated into funds diverted from this project has not yet been determined.

The funding deficit in the General Dynamics Centaur stems from fixes required following the unsuccessful first Atlas Centaur flight last May 8 (AW May 14, p. 36). Most significant fix is addition of approximately 600 lb. of insulation to the four jettisonable quarter-panels around the hydrogen tank.

Vincent L. Johnson, NASA's Centaur program chief, indicated that the program faces a deficit of about $35 million. He said the money will be reprogramed within the agency. NASA requested $66.7 million for the Centaur development program this year.

Heavier insulation and stronger connections on the Centaur stage structure will be incorporated in the second Atlas Centaur test, now scheduled for February, 1963. The 10-vehicle development program, originally scheduled to be completed by the end of 1963, probably will extend at least through 1964 because of the long series of development difficulties the stage and its Pratt & Whitney RL-10 engines have experienced (AW May 28, p. 33).

Both NASA and its prime Centaur contractors maintain that the difficulties have been overcome. Grant Hansen, General Dynamics vice president and Centaur program director, last week told an American Rocket Society meeting here that the accomplishments of Centaur in development of high-energy technology are of far greater technical significance than the highly publicized problems the program has experienced.

Hansen said, however, that the U. S. should have active programs in other high-energy propellants. "We shouldn't stick our heads in the liquid hydrogen sand," he said.

In his talk on Centaur, Hansen said the insulation fix will be accomplished in two steps—the first will be "brute force" for the next few flights, during which time the insulation data will be refined. In the second step, weights will be reduced. The 600 lb. of insulation will reduce payload capability by 30 lb., Hansen said.

Although the added funds for Centaur would in themselves require a sizable reprograming in NASA, it is the lunar orbit rendezvous decision that will significantly change the Fiscal 1963 program as it has been presented to Congress. The House and Senate are now attempting to compromise on the final appropriation. House has recommended $3.6 billion and senate, $3.7 billion.

Complete development cost of the two-man lunar landing vehicle is estimated at $300-$500 million, and NASA hopes to award a contract for this system in October (AW July 30, p. 25).

Saturn C-1B is considered to be an interim step between the C-1 and the C-5, which will be used to carry the Apollo system to the lunar landing mission. The C-1B consists of the same S-I booster stage used in the C-1, and the S-4B stage which will be the third stage of the C-5.

The C-1B is a critical vehicle in the Apollo program because it will be used to qualify the Apollo spacecraft in earth orbit, including transferring two astronauts from the command module to the lunar landing module. The C-1B is scheduled to be operational in 1965.

The agency will tailor Fiscal 1963 funding of the bug, the unmanned lunar supply system (AW Aug. 13, p. 30) and the Saturn C-1B on the basis of information being generated by industry and in-house on these programs. NASA would like to get all of them into hardware phases this year, which would require initial funding of about $50 million for each.

A key NASA official emphasized that funds allocated for science projects will not be diverted to manned space flight, and he said this has not been done in the current Administration.

A summer study group, consisting of leading U. S. scientists, met for several weeks recently at the State University of Iowa (AW Aug. 13, p. 26), and a recent lunar missions meeting in Blacksburg, Va. (AW Aug. 20, p. 25) was held to give scientists an opportunity to voice their views of the space program. Both sessions were sponsored by the National Academy of Sciences at NASA's request.

Goldstone Antenna

Selection of a contractor to build a multi-million-dollar, 210-ft. antenna system to increase tracking capability of Jet Propulsion Laboratory's Goldstone Deep Space Instrumentation Facility (AW Aug. 6, p. 23) is narrowing to competition among a handful of industry teams, each composed of several companies.

Tentative team lineups as of late last week included Radio Corp. of America and Blaw Knox, Dalmo Victor and Consolidated Western Steel, Sperry Rand and Perkin-Elmer with Burns & Roe, and Rohr Aircraft and Minneapolis-Honeywell.

Proposals are due later this month.

Six Cameras on Rangers 10-14

Los Angeles—Ranger spacecraft 10 through 14, the five unmanned lunar spacecraft whose addition to the unmanned lunar exploration program (July 16, p. 32) is expected to be announced shortly by National Aeronautics and Space Administration, will each carry a six-camera TV package to obtain high resolution pictures of the lunar surface before impacting on the moon.

As tentatively planned, the five additional Ranger spacecraft (plus one spare) will be almost carbon copies of Rangers 6 through 9, scheduled for launch from Cape Canaveral during 1963. The payloads for Rangers 10 through 14, like Rangers 6 through 9, are expected to be supplied by Radio Corp. of America's Astro-Electronics Division, Princeton, N. J.

While the high-resolution picture mission is presently slated for the follow-on Rangers, other possible missions are under study at Jet Propulsion Laboratory which manages NASA's unmanned lunar program. One of these is the possible use of a modified version of the payload aboard Ranger spacecraft 3 through 5 as a lunar orbiter for a surface mapping mission.

In this version, the retrorocket supplied by Aeronutronic Division of Ford Motor Co., would provide sufficient thrust to send the complete spacecraft, including TV camera, into orbit around the moon. This would provide a backup for the Surveyor orbiter (AW July 23, p. 22).

JPL was expected to conclude technical evaluation of industry proposals for the Surveyor orbiter's payload, known as VIS—Visual Instrumentation Subsystem (AW July 23, p. 22)—by late last week.

Several of the eight proposals for the job probably will have been eliminated before an investigation of prospective contractors' facilities begins shortly.

The eight companies which submitted proposals for VIS are Fairchild Camera and Instrument Corp., General Electric, Itek, Lear Siegler, Norden Division of United Aircraft, Astro-Electronics Division of RCA, Space Technology Laboratories and Westinghouse.

Meanwhile, Milton Bollock, assistant Surveyor project manager at JPL, reported in a talk before the recent Western Electronic Show and Convention here that the first launching of a Surveyor soft-landing spacecraft has, as expected (AW July 2, p. 196), slipped beyond initial schedule delays into 1964 because of Centaur booster problems.

Bollock also indicated that Surveyor weight had been trimmed about 400 lb. to a gross weight of 2,100 lb., primarily at the expense of instrumentation payload and main spacecraft retrorocket propellant. Scientific payload for the Surveyor soft-lander, including its three TV cameras, is expected to run about 114 lb., rather than the 200-300 lb. originally allocated to it.

Current weight distribution for the soft-lander, according to Bollock, will be: spacecraft propulsion and propellant, 1,560 lb.; flight controls, 517 lb.; electronics, 97 lb.; electrical power, 55 lb.; mechanics, 30 lb.; the spacecraft itself, 196 lb.; and scientific payload, 114 lb.

Surveyor will be equipped with a completely redundant electronics system to insure it further against failure in a single element of the system, Bollock said. It will carry two transmitters, two receivers and two central command decoders. The transmitters will have 10-w. and 100-mw. transmission modes.

Nimbus Slip May Add Tiros Shots

Washington—U. S. may launch three Tiros satellites in addition to those now planned to help fill the weather information gap that will result from a slippage of as much as a year in the Nimbus program.

Dr. Francis W. Reichelderfer, Weather Bureau chief, told a House Science and Astronautics space subcommittee last week that "it is quite definite" there will be six months slippage in Nimbus and it is "quite possible" the lag "may be as much as 12 months."

Nimbus originally was scheduled to be launched during the second quarter of 1962 (AW Jan. 22, p. 54). But Defense Department and Weather Bureau officials said the launching is now expected in the second quarter of 1963. They blamed technical difficulties.

Dr. S. Fred Singer, director of the bureau's National Weather Satellite Center, said the primary difficulty was in the attitude control system (AW July 10, 1961, p. 77). General Electric's Missile and Space Vehicle Department is manager for that system, as well as for systems integration and tests. A General Electric spokesman told AVIATION WEEK there have been problems in perfecting the system's horizon scanners in the past, but that the attitude control system is now on schedule.

Singer said within a matter of weeks, the Weather Bureau will finish a proposal to launch three additional Tiros satellites to fill this expected gap in the Nimbus program. The bureau now is determining the interest of other government agencies in transforming Tiros temporarily into an operational rather than a research program for gathering weather information, he said.

The group to be consulted on this plan is called the Working Committee on Satellites of the National Coordinating Committee for Aviation Meteorology. Represented on the committee are the Coast Guard, Commerce Department, Defense, Federal Aviation Agency, National Aeronautics and Space Administration and State Department. Singer indicated the plan would be received favorably. Reichelderfer said the next step would be to get Commerce Department approval to reprogram funds for the new approach.

Currently, there are three Tiros research satellites on the shelf. Singer said his plan calls for launching an additional three at a cost of about $3.5 million each. He said the operational Tiros probably would not carry infrared sensors and would be simplified in other respects for its role as an operational rather than a research satellite.

Reichelderfer said technical advances may reduce the lag now expected, adding that the extent to which Tiros will be used as an operational satellite will depend on progress with Nimbus. He said the bureau was very much aware of the urgency surrounding the Nimbus program. Chairman Ken Hechler (D., W. Va.) said his subcommittee "intends to keep the heat on to find out what is delaying the Nimbus development."

Air Force Lt. Col. Leslie W. Cowan of the office of the deputy chief of staff for systems and logistics also expressed dismay that the Nimbus program was lagging. He said defense policy is to use the national weather gathering system unless "an urgent, unique military requirement for weather satellite observations could not be satisfied."

Because of slippage, he said "military operational use of the complete Nimbus system will be delayed until 1965 or later unless an intensive effort or modification in plans is initiated." The subcommittee is studying the management of the Nimbus program. The Weather Bureau receives the money for Nimbus but NASA is developing it.

Dr. Morris Tepper, NASA weather systems chief, told the subcommittee the Nimbus slippage cannot be corrected unless the program is put on a crash basis. He said NASA has conducted the program on an "as soon as possible" basis and had no indication that Nimbus development was urgent. Weather Bureau has expressed satisfaction with NASA's Nimbus performance.

Mariner Venus Shot Appears Successful

Washington—Midcourse correction maneuver to bring the Mariner 2 spacecraft within 10,000 mi of the planet Venus was to be attempted today as the next critical event in the U S Venus fly-by shot Payload was launched successfully Aug 27 and was returning clear engineering and scientific telemetry data during the early phases of flight

Jet Propulsion Laboratory, which directs National Aeronautics and Space Administration's planetary programs, was to command the first phase of mid course correction, earth acquisition, yesterday and to fire the course-correction motor sometime today

An extremely sensitive photo-multiplier tube, which will be used to acquire the earth, cannot be activated too close to the earth because the earth's albedo might burn it out Mariner was to be about 1 2 million mi from the earth at 8 a m (EDT) today

Soviet Russia, meanwhile, was still expected as of late last week to attempt a mission similar to that of Mariner 2 U S considers the last good flight date for a Venus mission to be Sept 13 with no further opportunities for the next 19 months

Russia launched a Venus probe from the orbiting Sputnik 8 on Feb 12, 1961 Probe stopped transmitting after 18 days of flight, but Russia said it passed within 62,500 mi of Venus on May 19, 1961 U S failed in its previous fly by attempt last July 22 in a failure traced to a faulty flight path equation (AW July 30, p 27)

The 447-lb Mariner 2 was launched at 2 53 a m Aug 27 from the Atlantic Missile Range by an Atlas Agena B vehicle It is scheduled to pass Venus in early December after a flight of 180 2 million mi The 10,000-mi miss distance is calculated to be close enough to conduct measurements and far enough away to avoid an impact that might cause contamination of Venus

It was feared immediately after the launching that the spacecraft would pass no closer than 100,000 mi to Venus because of an unexplained roll in the Atlas during the boost phase First telemetry indications were that the roll rate was extremely high—1 5 cps Later on launch day, better telemetry showed the rate to be 0 5 cps Final data indicates the vehicle rolled over only 2-4 times in a 50 sec period and probably came back to its precise trajectory when the roll stopped

Early Figures

On the basis of early figures, NASA computed that without a midcourse correction, Mariner 2 would miss Venus by at least 500 000 mi With a correction, it estimated the miss distance could be reduced to 100,000 mi NASA thought it would be necessary to come within 25,000 mi to make precise scientific observations

Latest figures put the miss distance at 250,000 mi which can be corrected by the midcourse pointing maneuver, and a velocity increase of 80 mph , to bring Manner 2 within the desired 10 000 mi miss

On Aug 28 JPL said the spacecraft was returning engineering data as clearly as it had in pre-flight testing

The four interplanetary science experiments were activated at 12 13 p m EDT on Aug 29, on command from the Johannesburg South Africa station when the spacecraft was 447 897 mi from the earth These experiments are designed to obtain data on particles, magnetic fields and cosmic dust during the flight to Venus (AW Aug 13, p 68)

The four experiments are operating simultaneously, and information from them is being telemetered at the rate of 84 bits/sec They will be inactivated periodically during the flight, and during the midcourse correction maneuver They will be kept on during the Venus encounter, but the sampling rate will be reduced to accommodate planetary experiments

Engineering data, being received at the rate of 334 bits/sec , provided information on the spacecraft environment, midcourse motor temperature, roll rate and electrical power consumption

Optimum time for starting the midcourse maneuver was computed to be between 167 and 192 hr after launch, which would be between 1 53 a m EDT today and 2 53 a m tomorrow

Engineering and scientific data will share Mariner telemetry circuits until 10 hr before what is called a Venus encounter The period of encounter is from 10 hr before to 46 7 hr after the closest approach to Venus During this 56 7-hr period, only scientific data will be transmitted and then the telemetry will return to an engineering science sharing cycle

Excellent performance of the Atlas Agena B launch system (see box) resulted in an injection of Mariner 2 into an escape trajectory at a velocity of 25,551 mph The spacecraft is continually slowing relative to the earth, and will reach a minimum velocity about Sept 11, when speed will slowly increase until velocity at the Venus encounter will be about 90,000 mph

JPL is confident that the three-station Deep Space Instrumentation Facility will be able to track the Mariner payload to a distance of 100 million mi from the earth, according to Robert J Parks, project director At the point of closest approach, the spacecraft will be about 36 million mi from the earth

JPL's Goldstone, Calif , facility, which has been improved, tracked the Pioneer 5 probe to a distance of 22 5 million mi after its launch on Mar 11, 1960 The other deep space tracking stations are located at Johannesburg and at Woomera, Australia

Central computer and sequencer in the satellite is supplying the timing for Mariner 2 events, including the important midcourse maneuver In this event, the spacecraft, which has been locked on the sun since early flight, is rolled on its long axis until it acquires the earth using a photo-multiplier tube aligned with the high-gain antenna

Goldstone has an over ride command in case the spacecraft erroneously acquires the moon instead of the earth This capability involves commanding the spacecraft to roll again

With Mariner-sun and Mariner-earth axes, the spacecraft is ready for precise pointing commands for roll, pitch and amount of velocity increase for the correction motor

Roll maneuver will require a maximum of 12 min , and pitch 22 min When these maneuvers are completed, the midcourse motor is fired with velocity rates supplied by a pulse-balanced accelerometer representing a velocity increment of 0 98 fps

Midcourse motor, which weighs 37 3 lb , is fueled by hydrazine and uses nitrogen tetroxide as oxidizer Catalyst consists of aluminum oxide pellets The motor can burn in pulses as brief as 50 milliseconds to provide up to 50 lb thrust for 57 sec Velocity increment can be varied from 0 7 fps to 187 fps

Required velocity increment, which could be changed before the midcourse maneuver is attempted, was computed to be less than 120 fps

Following the pointing and velocity change, the sun sensors and photo-multiplier tube will again acquire and lock on the sun and earth and Mariner 2 will be considered in the cruise mode

As the spacecraft initiates its Venus encounter, 10 hr before the predicted closest approach time, scientific instruments will be calibrated on the basis of the latest miss distance information

Scientific planetary payload consists of a microwave radiometer and an infrared radiometer The microwave device will scan the Venusian surface at 13 5 and 19 mm wavelengths to determine whether water vapor exists on the planet The infrared experiment will measure in the 8-9 and 10-10 8 micron wavelengths to observe temperature and atmospheric conditions

Mariner 2 spacecraft was built by JPL with experiments supplied by JPL, Massachusetts Institute of Technology, Army Ordnance Missile Command, Harvard College Observatory, University of Nevada, University of California at Berkeley, NASA's Goddard Space Flight Center, California Institute of Technology, State University of Iowa

Principal contractors and subcontractors in the mission were General Dynamics/Astronautics for the Atlas, Lockheed for the Agena B, and the following instrument and hardware suppliers for the spacecraft

Aeroflex Corp , American Electronics, Inc , Ampex Corp , Applied Development Corp , Astrodata, Inc , Barnes Engineering Co , Bell Aerospace Corp , Computer Control Co , Inc , Conax Corp , Consolidated Electrodynamics Corp , Consolidated Systems Corp , Dynamics Instrumentation Co , Electric Storage Battery Co , and Electro-Optical Systems, Inc

Also Fargo Rubber Corp , Glentronics, Inc , Groen Associates, Houston Fearless Corp , General Precision, Inc , Marshall Laboratories, Matrix Research and Development Corp , Menasco Manufacturing Co , Midwestern Instruments, Minnesota Mining & Manufacturing Co , Motorola, Inc , Northrop Corp , Ransom Research, Rantec Corp , Ryan Aeronautical Co , Textron Electronics, Inc , State University of Iowa, Sterer Engineering and Manufacturing Co , Texas Instruments, Inc , and Trans Sonics, Inc

Atlas Agena Performance

Washington—Excellent performance of the Atlas Agena B launch vehicle for the Mariner 2 Venus probe is shown by this comparison of scheduled and actual times for critical events All actual times were well within mission limits Actual times are listed first. Times are given in seconds after launch

- Booster engine cutoff, 135.6 and 136 2
- Booster separation 140.18 and 141.7
- Sustainer engine cutoff 279 83 and 278 3
- Vernier engine cutoff, 295 03 and 295 3
- Shroud ejection, 296.88 and 296 3
- Atlas separation, 300 08 and 299.8.
- First Agena ignition 339 23 and 344 0
- First Agena cutoff, 485.05 and 491 0
- Second Agena ignition, 1,469 08 and 1,470
- Second Agena cutoff, 1,563 and 1,568
- Agena separation, 1,722 and 1 724.
- Agena retrofire, 1,935 28 and 1,934

Mars, Venus Soundings

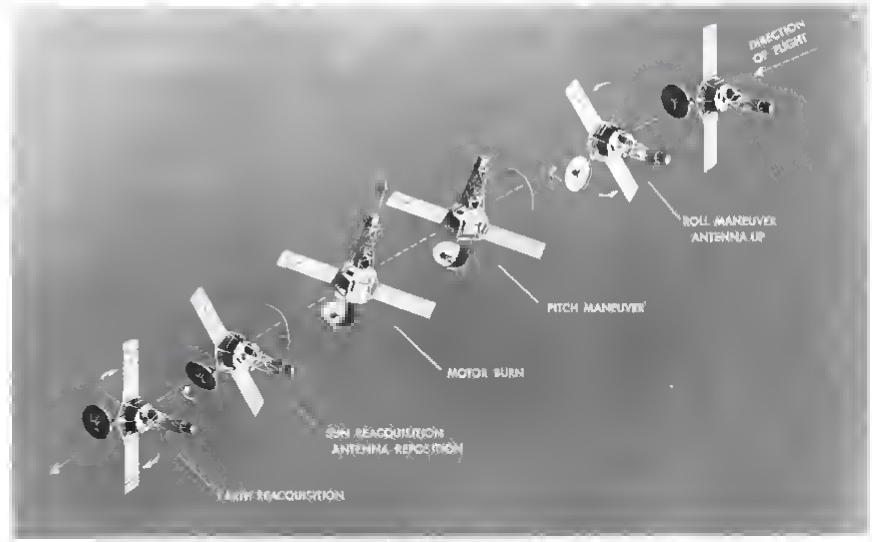
National Bureau of Standards Central Radio Propagation Laboratory and Airborne Instruments Laboratory will conduct joint studies of techniques for sounding the ionosphere of Mars and Venus from planetary flyby probes under separate one-year contracts from National Aeronautics and Space Administration

As part of the effort, Airborne Instruments will develop breadboard techniques for a high frequency transmitter and receiver system suitable for sounding planetary atmospheres from a maximum flyby distance of 40 000 km

The package would transmit signals to the planetary ionosphere on three frequencies between 1 and 6 mc., pick up returns and calculate range and range rate. In this fashion, a three-level profile of electron and ion density could be calculated

Actual altitude of the ionosphere above the planet's surface would be determined with the aid of range and range rate data, knowledge of the spacecraft's trajectory and time of flight.

Central Radio will design the experiment, and Airborne will develop suitable equipment, which is not expected to draw more than 100 or 150 w. peak power



CRITICAL MIDCOURSE CORRECTION maneuver illustrated in this sequence is designed to bring the Mariner 2 spacecraft within 10,000 mi of the planet Venus Maneuver is scheduled for sometime today Correction motors are fueled by hydrazine pressurized by nitrogen, with nitrogen tetroxide as oxidizer Maximum thrust is 50 lb , with a 57-sec burning time Motor can be fired in bursts as short as 50 millisec , and velocity increases varied from 0.7 to 187 fps

Profit Firms Favored for Management Aid

By Katherine Johnsen

Washington—Assignment of major atomic energy and space management roles to profit-making industrial contractors was endorsed last week in testimony to the House Military Operations Subcommittee by Dr Glenn T. Seaborg, chairman of the Atomic Energy Commission, and Dr Robert C Seamans, associate administrator of National Aeronautics and Space Administration

Under the Apollo lunar landing program, NASA has contracted with Bellcomm, Inc, a subsidiary of American Telephone & Telegraph Co, to develop systems requirements NASA also has given General Electric Co responsibility for systems performance, including some testing, checkout, and integration functions

Many of AEC's major installations are operated by industrial concerns under contract Examples are Sandia Laboratory, operated by Sandia Corp, a subsidiary of AT&T, Knolls Atomic Power Laboratory and Hanford Atomic Plant both operated by General Electric

Seamans said that it was in the government's interest to utilize existing organizations rather than to go through the time-consuming process of establishing a new in-house organization or nonprofit organization He pointed out that this will give NASA flexibility to cut back its effort Bellcomm and General Electric, Seamans emphasized, will be "project oriented not agency oriented," as non-profit organizations that serve Defense Department, Air Force and Navy are

Bellcomm's current staff of 92 will be expanded to a one of 250 highly experienced scientists, mathematicians, and engineers drawn from various parts of the Bell Telephone Laboratories and Western Electric, Seamans said NASA's annual contract level with the company, including computer rentals will be about $15 million he said Bellcomm's headquarters in Washington are separate, but easily accessible to NASA

'Bellcomm makes recommendations only to NASA's own systems engineering staff," Seamans said "Any directions to participating hardware contractors will be handled by NASA officials"

NASA's contract with General Electric initially will cost about $30 million a year Seamans presented these details to the subcommittee

"General Electric will furnish a substantial proportion of the special instrumentation requirements beyond those for which existing hardware is available Correlation of these measurements with those obtained for the various stages or systems under test conditions is an essential, so General Electric must deal very closely with the several prime contractors to identify those data requirements for which common instrumentation is needed

' In this connection, General Electric will assess over all performance reliability for each of the major stages in the Apollo program To this extent, General Electric will be furnishing technical staff services which augment our in house capability However, NASA will evaluate each of these studies and determine for itself what requirements will be laid upon contractors to achieve such reliability goals, ' Seamans said

"General Electric will prepare detailed specifications for each element of the integrated checkout system and in all cases will make its findings to NASA The government will retain final judgment concerning any equipment to be placed in the system it will issue any instructions which go to the associated prime contractors, and it will retain make-or buy decision authority with respect to any special gear which is not otherwise commercially available General Electric will operate some of the test and checkout equipment at the prelaunch sites at Cape Canaveral"

Herbert Roback counsel of the subcommittee, told AVIATION WEEK that the success of the AT&T and General Electric operations 'depends largely on whether they are accepted by industry and whether contractors will cooperate with them"

In 1959 the subcommittee was highly critical of Air Force's use of a profit-making firm, Space Technology Laboratories, Inc, for technical direction of its ballistic missile program, and insisted that STL 'must be converted into a nonprofit institution" Largely as an outcome of subcommittee pressure, Air Force formed Aerospace Corp, a nonprofit firm to succeed STL in the technical role

Although NASA has not yet completed its contracts with AT&T and GE, Seamans said that NASA Administrator James E. Webb has outlined to AT&T the areas in which it will be able to compete for future NASA business without any conflict of interest He said that GE's bid on a space truck study (AW Aug 27, p 28) involves no conflict-of-interest, since this project is "separate and distinct from Apollo and advanced Saturn"

Seaborg said that contractor operation of AEC's installations has been "very impressive" and that a shift to government management, in addition to being disruptive, would result in "marginal if any, improvement" He conceded under questioning that AEC has generally become wedded to the existing contractor at a laboratory, but is now 'consciously looking into the possibility for change"

Rep. Chet Holifield (D-Calif.), subcommittee chairman noted that GE—which started operation of the Hanford Atomic Plant on a nominal $1-a year fee—is now earning a standard management fee This amounted to $2 2 million for 1961

Seaborg said AEC's policy is to have systems engineering performed by the prime industrial contractor—for example, Aerojet General Corp for the Nerva engine and Westinghouse for the Nerva reactor under Project Rover

Apollo to Have Three TV Cameras For In-Flight Data, Exploration

Three types of television cameras will be aboard the Apollo spacecraft on the lunar-landing mission transmitting real-time information to the ground

One camera will monitor crew, one probably will be fitted on a panning head on the rear of the service module to view exhaust flame patterns and hand-held equipment will be used by the astronauts during lunar surface exploration

Precise specifications regarding picture quality apparently have not yet been established, but indications are that less than standard consumer home set quality will be accepted, perhaps on the order of 10 frames/sec and 278 lines/in This performance is considered adequate for lunar operations The same equipment operating from earth orbit probably would give performance on the order of 30 frames/sec and 400 lines/in

Although details are not yet available, partially because the choice of equipment is still under study, both analog and digital transmission are under consideration, though it is likely that the less-sophisticated former technique will be favored

Considerable testing of competitive equipment is being carried out at Collins Radio Co, Cedar Rapids, Iowa utilizing a full-scale Apollo spacecraft mockup located on a set that includes a portion of a lunar landscape and sky presentation, permitting remote viewing and evaluation by National Aeronautics and Space Administration and North American Aviation Space and Information Systems Division technicians

Equipment work statement specified running these experiments with a simulated lunar background

Also expected to be carried is equipment to collect data and several experiments including a gravitometer, magnetometer, radiation spectrometer, seismographic analysis and rock and soil analysis

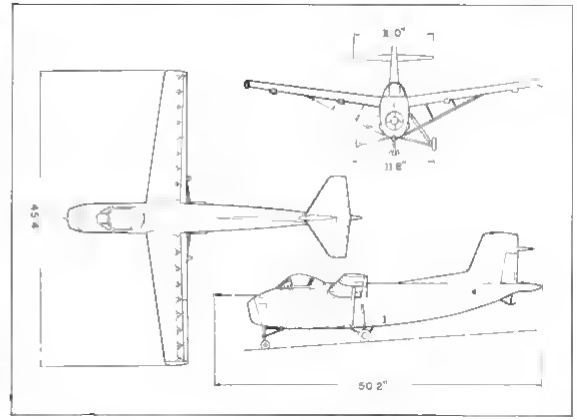
Rock and soil analysis probably will require that astronauts physically detach lunar samples

Apollo communications, telemetery and TV equipment will not stretch the state of the art Actually, they will be some two to three years behind, due to a philosophy of accepting 'adequate' performance and thereby gaining higher reliability Emphasis is on ability to perform in-flight maintenance, using in-flight automatic checkout equipment to locate the problem, care in construction technique and extremely high degree of quality assurance and testing As an example of reluctance to incorporate new developments Apollo equipment will utilize no tunnel diodes, on an arbitrary basis that there is still a relatively low experience level with these devices rather than because of lack of confidence based on actual reliability records Solid-state circuitry will not be used extensively in the equipment, for same reason

Collins Radio equipment probably will utilize the Space Electronic Package (SEP) concept, utilizing pull-and-replace modules in the black boxes To simplify spares stocking problems, some modules such as the audio stage in several equipments will be common to several boxes

PCM telemetery equipment in Apollo will provide an on-board patching capability to permit continued collection of quantitative data in case of surprises that might otherwise saturate the equipment, as in the case of early probes of the Van Allen belt, where the return was so much higher than anticipated that data only indicated extremely high radiation concentrations, rather than quantitatively defining the levels

Hunting H.126 Jet-Flap Research Vehicle Shown



First photo of Hunting H.126 jet-flap research aircraft, which started taxi tests last week at the Hunting Aircraft plant in Luton England shows configuration of the strut-braced, high wing monoplane being readied for its first flight (AW July 23 p 15). The H.126 was built to British Ministry of Aviation specification and is powered for both propulsion and lift. Efflux from the engine is ducted into the wings and ejected as a gaseous sheet from the wing trailing edge. Full span flaps act as jet stream deflector. Stream follows the flap as it is lowered, providing thrust as well as lift, further thrust is provided through nozzles on the lower fuselage just aft of the main landing gear. Ailerons serve as outboard sections of the flap. Control is supplemented by pitch and yaw nozzles at the tail for use at low speeds. Wingtips are fitted with roll nozzles which are operated by an autostabilizer

Miller Opposes Changing Space Program

Washington—Chairman George P Miller (D -Calif) of the House Science and Astronautics Committee opposes changing the national space program's direction and believes "all this squabble about the military in space stems from an in-house difference of opinion within the military establishment"

Rep Miller, in a speech prepared for delivery in the House late last week attempted to rebut senators who contend the flights of Vostoks 3 and 4 threaten U S security to the point that it is urgent to increase the military's role in the national space program (AW Aug 20, p 31)

"I don't believe we need to throw the panic switch at each new Russian achievement in space," Rep Miller said "It would be the height of diplomatic irresponsibility to immediately the Soviets or to abandon our emphasis on the peaceful exploration of space—an emphasis which the American government evolved with careful deliberation in the National Aeronautics and Space Act of 1958

"In this modern age our first line of defense rests with what others think of us," Rep Miller said "And I submit that the broad scope of our peaceful space program, plus the enormous promise it holds for a better life for all men, is doing much to enhance America's stature in the world community

"If we fail in this area and thus gradually sink in the estimation of other nations, if we abandon peace as our fundamental policy in space in favor of an all consuming military role, then we are asking for it We may then have to use our military might and suffer all the dreadful consequences of being forced to do so"

The House space committee chairman said it was illogical to blame the National Aeronautics and Space Administration for holding back military developments in space He said the civil space program was enhancing the military one but that "the problem is that the military space enthusiasts have not been able to obtain all the green lights they want from their bosses"

Rep Miller said Congress was well aware of the military implications of space and had been generous in voting funds for such programs He said he could not understand those who favor "initiating a program when the requirement it must meet is unknown or can be better met by another system" He endorsed the stand of Dr Harold Brown Defense director of research and engineering, who feels there are no urgent, demonstrable military requirements that are not being met

Rep Miller said military space spending to date has totaled $4 8 billion compared with $6 4 billion for NASA He said this 43% share for the military certainly is not "flagrant disregard" of that interest He broke the total military spending down this way, using round figures

- **$500 million for Vanguard,** Explorer, Discoverer and other satellite systems
- **$1 5 billion for reconnaissance** and intelligence satellite systems such as Samos and Midas
- **$400 million for communication** and navigation satellites, including Advent, Courier and Transit $100 million for Spadats, $500 million for space plane research including the X-15 and Dyna-Soar, $75 million for satellite inspectors, $1 5 billion for large boosters and miscellaneous research and development projects

Rep Miller took issue with military space projects recommended by Sen Howard W Cannon (D.-Nev), declaring they were already under way either in NASA or the Defense Department "The critics of our space program," Rep Miller said, "are not asking that we do twice as much but that we do everything twice"

As for the Vostok flights, Rep Miller said the Soviets demonstrated two "important capabilities" (1) launch facilities and rocket reliability to get off several difficult space shots in a short time (2) progress toward assembling a space laboratory He said it was "ridiculous" to conclude that the Russians have an operational space weapons system The Vostok flights and other Russian space feats "are no reason for us to put our program in a constant state of flux, with projects starting, stopping and shifting in response to each new Soviet development I don't believe we are doing badly," Rep Miller said

Low-Temperature MHD

New York—General Electric scientists believe they can reduce the operating temperature of a magnetohydrodynamic (MHD) generator by approximately two-thirds and, in so doing make this type of power source compatible with a nuclear reactor for a nuclear electric space engine

Scientists at GE's Missile and Space Vehicle Dept , Valley Forge, Pa , plan to introduce a seed, or additive, gas—such as neon, cesium or potassium—into a primary argon gas flow within an MHD generator The argon will be heated to about 1,300F by a simulated reactor upstream of the seed gas injection The theory is that the seed gas, excited by the hot carrier gas in a constant magnetic field will become ionized without an additional external heat source

GE scientists say that ionization, which is a central element of magnetohydrodynamics, at this temperature is considerably below the lowest temperature ever reached with other MHD generators —about 4 600F

At 1,300F and slightly higher heat levels, GE scientists say, small nuclear reactors operating in this temperature spectrum can be used to drive the gases without extreme concern over erosion in the materials of which the generator is built

Under contract to the Office of Naval Research in conjunction with the Advanced Research Projects Agency and USAF's Aeronautical Systems Division, GE now is building three MHD generators to test the theory with the three seed gases mentioned above.

NASA Starts Postcard Check of Contractors

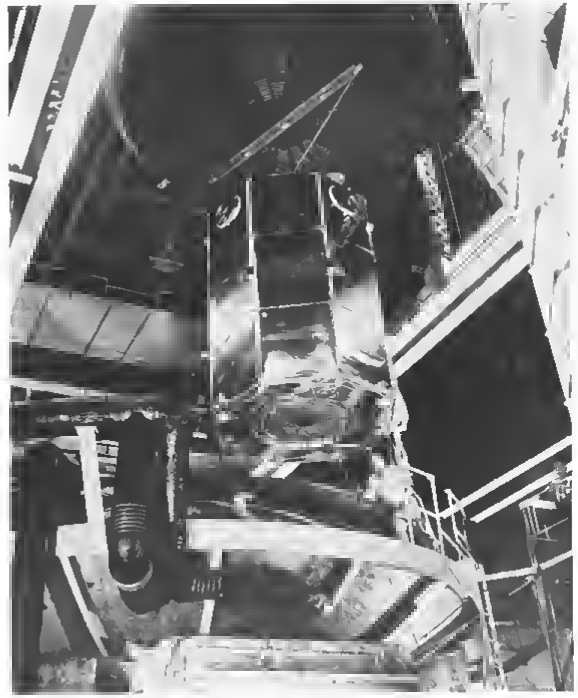
Washington—National Aeronautics and Space Administration last week announced a new reporting system that will enable it to keep close check on first and second tier subcontracting under its prime contracts

It consists of an addressed postcard, which will be dropped in the mail to NASA at the time each subcontract for over $10,000 is let, giving the name of the subcontractor, the item or service procured, the dollar amount of the procurement and telling whether the subcontractor is a small business firm and where the work will be done

NASA has been eager for months to initiate the system which, for the first time, will enable it to develop an accurate picture of the geographical distribution of its procurement dollars and the amount being channeled into small businesses and labor surplus areas NASA's major industry contractors opposed the plan as more red tape (AW July 16, p 25) Budget Bureau finally authorized initiation on a trial basis

"This will give us a means of keeping account of how our contractors are doing in carrying out their contractual commitments to help labor surplus areas and small business concerns," Ernest W Brackett, NASA's director of procurement and supply, told the Senate Small Business Committee

Defense Department's procurement surveys cover data on prime contract awards only Since a large portion of the work under defense prime contracts is subcontracted out there is no accurate information available on the impact of defense spending on geographical areas or small firms



OAO Satellite Enters Vacuum Chamber

Thermal model of the Orbiting Astronomical Observatory (OAO) entered a 15 ft -dia. space environment simulator recently at Grumman Aircraft Engineering Corp.'s Bethpage, N Y , facility to begin a 39-day test of the satellite's passive temperature control system (AW Feb 13 1961, p 54) Model's external skin was thinner than that to be used on flight vehicles, but weight—3,300 lb.—was identical with operational OAOs. Continuous test period of about 1 000 hr. will provide data on the effects of heat and cold on the OAO vehicle in a hard vacuum of approximately 300 mi. Structural distortion also will be tested.

Cost Accuracy Legislation Passed

Washington—Legislation requiring Defense Department and National Aeronautics and Space Administration contractors to certify the accuracy of costs on negotiated contracts was sent to the President last week for signature

The main objective in passing the measure was to discourage two practices that have caused widespread congressional criticism

- **Inflated costs** on incentive type contracts which subsequently give rise to what Congress considers windfall profits from fictitious cost "savings"
- **Under-bidding** on research and development contracts to "buy in" on a major program, with anticipation that after the project is under way the government will finance add-ons as they develop

The proviso requires a prime contractor or any subcontractor "to certify that, to the best of his knowledge and belief, the cost or pricing data he submitted was accurate, complete and current"

The wording "to the best of his knowledge and belief," was added to the proviso partially to meet strong industry opposition to the legislation

Without this qualification, H M Horner chairman of United Aircraft Corp., told the Senate Armed Services Committee, "the conscientious contractor may never be able to file such a certificate, or if he can, it will be only after incurring great expense and delay in assuring himself that every one of the three conditions has been unequivocally fulfilled"

The proviso will be required on all prime and subcontracts in excess of $100,000 and on all prime or subcontract modifications or changes in excess of $100,000

GAO Check

Although an armed services regulation already requires certification of cost accuracy, a check by General Accounting Office showed that out of 364 contracts negotiated since the regulation was issued in October, 1959, 121 failed to include the certification

While the new legislation places the burden of vouching for accuracy on the contractor, the regulation left it with the contracting officer It required a contractor to certify that "to the best of his knowledge and belief all actual or estimated costs and pricing data have been considered and made known to the contracting officer for his use in evaluating the estimate"

The legislation also requires detailed written justifications of negotiated procurements Although existing law already requires written findings, according to General Accounting Office, in practice they have become 'stereotypes"

Bill Requirements

Under the new legislation, the justification must set forth 'facts and circumstances that (1) are clearly illustrative of the conditions described (2) clearly indicate why the type of contract selected is likely to be less costly than any other type or that it is impracticable to obtain property or services of the kind or quality required except under such a contract (3) clearly indicate why advance payments would be in the public interest "

A proviso which would have extended GAO's authority to invalidate defense contracts was eliminated in final congressional action on the legislation (AW July 30 p 21)

Soviet Observatories

Moscow—Six new astronomical observatories are under construction in various parts of the Soviet Union, according to Prof Alexander A Mikhailov, chairman of the USSR Academy of Sciences Council for Astronomy Soviet Russia has 36 astronomical observatories in operation now

New observatories are being built in Azerbaidzhan Kazakhstan, the Ukraine, Novosibirsk, Irkutsk and Tartu Mikhailov said the Tartu facility will become the central astronomical observatory establishment of the Baltic Republics

Military Board Approves XC-142 Mockup

By Erwin J. Bulban

Dallas—Detailed engineering drawings of the Vought-Hiller-Ryan XC-142 tri-service V/STOL transport will begin flowing into shops shortly for fabrication of components following the successful review of the full-scale mockup by a board of Air Force, Army and Navy officials.

Mockup board suggested no major changes in concept or design of the project. No safety-of-flight recommendations were made, and the few minor changes suggested dealt mainly with standardization and simplified maintenance, according to Chance Vought.

Wind tunnel test program on a one-tenth scale model currently under way is expected to result in a barely discernible refinement of aft fuselage lines to reduce some airflow separation calculated in earlier studies. (AW June 11, p. 69)

Vought also says that the company expects soon to start awarding contracts on vendor-furnished items. In some cases these contracts only await final negotiation over prices before a decision is made.

Under current scheduling, significant program milestones include:

- **Completion** of the first airplane in December, 1963, second in January, 1964, third in March, 1964, fourth in May, 1964 and fifth in July, 1964.
- **First flight test,** in the conventional airplane mode, probably near Dallas, in March, 1964. First VTOL flight is set for June, 1964, and the first hovering trial the following month.
- **Completion** of contractor test and evaluation in February, 1965, and completion of USAF's evaluation of the XC-142 by the end of that year.
- **Formal delivery** of the first airplane to USAF is scheduled by June, 1964, and the fifth airplane by March, 1965.

First five prototype airplanes, to be evaluated by all three services under conditions close to tactical use, will be minus some refinements to reduce complexity and save time and money until basic V/STOL transport concepts are proven.

Initial Airplanes

Initial airplanes, for example, probably will not use water-injection versions of the General Electric T64-GE-6 turboshaft powerplants. Some Navy requirements, such as folding surfaces to permit stowage below carrier decks via elevators, also will be deleted from prototypes, although such provision has been designed.

Wing fold, for example, will be handled with the wings in the vertical takeoff mode, panels folding backward just outboard of the fuselage. The upper vertical tail would fold over to the left, and the tail rotor also would fold to the left on a line just forward of the vertical tail.

Numerous design studies, such as one combining U. S. tri-service V/STOL transport requirements with North Atlantic Treaty Organization V/STOL transport needs, have been considered but are no longer active. Several early civil passenger and cargo transport configurations have been studied, but more detailed analysis probably will await further inquiry from airlines. This is not expected to become serious until the military aircraft have demonstrated their effectiveness.

Aircraft cabin, designed to carry 32 fully armed troops or up to 8,000 lb. of a large variety of cargo, including a 105-mm. howitzer and its ¾-ton truck prime mover, basically duplicates dimensions of the Vertol HC-1B Chinook.

Cabin features numerous emergency exit provisions, including egress via a ladder out the roof in the forward portion on the left, similar escape at the rear on the right side, an escape hatch in the belly of the forward cabin and two "punch-out" doors on either side of the aft cabin. The crew has roof type escape provision. The first five test aircraft will provide emergency ejection seats for the crew.

Wing-tilt will be accomplished by dual-synchronized, hydraulically actuated screw-jacks, either one capable of assuming the entire required forces for lifting the leading edge up through 100 deg., providing hovering capability in a tailwind.

Flaps on the fuselage fore and aft of the wing provide fairings when the wing is in the conventional flight mode. The program calls for using four engines in takeoff, hover and landing configurations. Cruising in the conventional mode will be done with two of the four engines completely shut down.

Airframe construction will be fairly conventional, with semi-monocoque fuselage composed of bulkheads, frames, longerons, stringers and skins. The tilt-wing center section main structural box will extend continuously over the fuselage. The horizontal tail, a conventional stabilizer-elevator configuration in early studies, now has been changed to a one-piece "slab" type.

Independence from ground-starting assistance will be provided by having an auxiliary power unit located in the rear of the right main landing gear pod. Two bladder-type fuel cells, one fore and one aft of the wing in the top of the fuselage, will flow fuel from a sump in the aft cell to dual cross-shaft-driven booster pumps and then into the engines.

No electrical power will be required for refueling or defueling. Hydraulic system will be utilized for operation of engine starting, power control, stabilization, utility and emergency systems.

Calculated performances include permissible VTOL gross weight of 40,900 lb. without water injection and 42,500 lb. with water injection at sea level on a standard day. 36,200 lb. without water injection and 39,700 lb. with water injection at sea level on a tropical day. Takeoff gross weight, VTOL, for 100-naut.-mi. radius would be 34,880 lb.—on a 200-naut.-mi. radius, 37,474 lb. (including 254 lb. of water).

Maximum gross weight, STOL, would be 44,500 lb., with a weight empty of 22,599 lb. Fuel load for a 100-naut.-mi. radius would be 3,500 lb. or 5,790 lb. for a 200-naut.-mi. radius. Payload would be 8,000 lb.

Assault Helicopter Award

Washington—Sikorsky Division of United Aircraft Corp. has been chosen by the Navy to develop and produce a heavy assault helicopter for Marine Corps limited war and counter-insurgency use. The helicopter is based on Sikorsky's S-64 Flying Crane (AW May 14, p. 37).

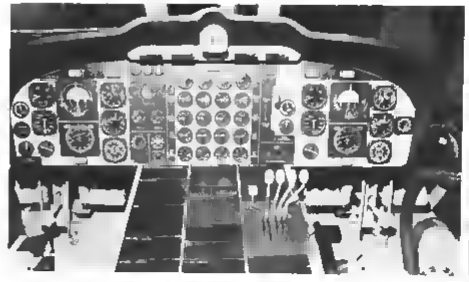
The crane uses two of United's Pratt & Whitney JTD12A-1 engines, rated at 4,050 hp. each. Sikorsky's proposal for the Marine helicopter called for use of two General Electric T64-6 gas generator-free turbine engines, 2,850 hp. each.

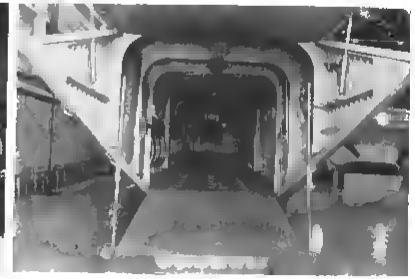
Company designation for the Marine helicopter is CH-53A. Proved elements included in the proposal were tail rotor, boom and transmission system to the tail rotor, main rotor system, engine mounting and transmission system, and the two-place cockpit. The proposal also draws on Sikorsky's experience three years ago in the competition for the Army's Chinook heavy assault helicopter, which was won by Boeing's Vertol Division.

Vertol proposed a version of the twin-engine, tandem rotor HC-1B Chinook for the Marine competition, but with the T64 instead of two Lycoming T55-L-5 engines, rated at 2,200 hp. each.

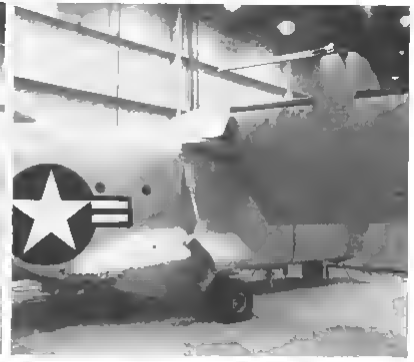
Original Marine requirement was for a vertical takeoff and landing aircraft with a four-ton capability. Since there was little hope of meeting this, the speed demand was reduced from 250 kt. to 150 kt. and the specifications were changed to permit modifications of existing helicopters. Main difference between S-64 and the CH-53A will be the addition of a fixed fuselage with clam shell doors and a ramp at the rear.

TRI-SERVICE XC-142 V/STOL ASSAULT TRANSPORT mockup is shown in cruise configuration with wing in fully lowered position and landing gear retracted. Top design speed is more than 300 mph. Span is 67.5 ft., length is 58 ft. and height is 26 ft. Engines are four General Electric T64-GE-6 turboshafts of 2,850 shp. each. Instrument panel layout, below, left, is installed in a separate mockup of the XC-142 nose section. Pilot is located on the right side, as in a helicopter (note collective pitch controls), but this decision is not final. Engine gages, center, are installed at various angles so that needles line up for easy malfunction detection.





CARGO-TROOP COMPARTMENT, above right is 30 ft. deep, 7.5 ft. wide and 7 ft. high. Integral loading ramp is included. Fuselage rests only three feet from the ground. Tail rotor, 8 ft. in dia., is high enough to permit straight-in loading. Rotor is connected to fuselage-mounted gear box. Long oleo of externally mounted gear, below left, is designed to absorb shock of heavy vertical landings. Note rotating wing fairing atop fuselage. XC-142 gross weight will be approximately 35,000 lb.



New Microcircuits Reported at Wescon

By Philip J. Klass

Los Angeles—Several new entries in the fast-expanding field of microcircuits, both semiconductor and thin-film types, and a new type of computer logic specifically designed for semiconductor microcircuitry, were disclosed here at the recent Western Electronic Show and Convention (Wescon).

However, microcircuit sales generally are slow and have not come up to early expectations, according to representatives of most companies contacted here.

Here are some of the advances reported at Wescon:

• **Texas Instruments** announced a "master slice" technique for rapid, low-cost fabrication of custom-designed semiconductor microcircuits, an approach similar to that recently disclosed by General Electric (AW Aug. 27, p. 69). The master slice consists of a silicon wafer on which 30 or more clusters of resistors, capacitors and transistors have been fabricated. These can be interconnected into the desired custom circuit by using a mask and photo-etch process to lay down the required aluminum conductor paths between individual elements.

• **Motorola Semiconductor Products** announced a new line of semiconductor microcircuit logic functions, capable of operating at any desired power level at speeds up to six nanoseconds. Company also reported that it can now produce custom-designed semiconductor microcircuits in six weeks or less, using a group of separate semiconductor sub-circuit chips suitably interconnected and mounted in a TO-5 transistor package. Motorola says that for crash programs it has fabricated multiple-chip semiconductor microcircuits in less than a week after receipt of the design configuration.

• **Philco's Lansdale Division** has placed on the market the first of a series of thin film microcircuits, available in a TO-5 or a flat package, using nitrides and oxides of tantalum to fabricate resistors and capacitors, and discrete micro-transistors. Resistor values can be controlled to within 0.02%, company says. The silicon epitaxial planar transistor is encapsulated after attachment to the substrate by vapor deposition of a thin layer of vapor. First of the thin-film microcircuits to be marketed include a high-speed gate, priced at $70 to $95, depending on quantity, and flip-flop, priced at $45 to $55, depending on quantity.

The logic circuit has a fan-in and a fan-out of three on a worst-case basis over an ambient temperature range of −25 to 100C, the company says. Philco also displayed at Wescon a thin film seven resistor ladder network and a four-bit parallel adder.

• **Corning Glass Works** announced plans for mass production of thin film resistor networks and flip flop circuits on a custom-design basis. Resistors will be fabricated from metal oxide, with tolerances of 2, 5 or 10% available and with temperature coefficients of 300 pts./million/deg C. Substrate materials will include alumina, optical grade glass and other materials.

• **Signetics Corp.** introduced four new semiconductor microcircuit computer functions, using diode-transistor logic and planar structures. The four new circuits include an exclusive-OR network, a buffer, a diode array and a transistor coupled NAND/NOR gate. Earlier, the company had introduced complementary NAND/NOR gate and a binary element. The new semiconductor microcircuit functions are priced at $30 to $94.50 in quantities under 100.

New Circuits

Because the individual components in a semiconductor microcircuit can not be fabricated to the tolerances of conventional components, new logic circuits must be developed whose operation is less dependent upon individual component values. Motorola has developed a new logic, specifically designed to minimize this problem, which also is expected to prove extremely reliable, provide a high-degree of immunity to noise and to be extremely fast.

The new logic can be operated over a wide range of speeds and power levels, according to Dr. Jan Narud, manager of circuit research. Motorola plans to bring out a complete series of three different families of semiconductor microcircuit computer functions each designed for a different range of operating speed, Narud said. Company demonstrated at Wescon a 30-stage multiplier adder, measuring only 2 x 3 x 0.05 in., which uses the new current-mode logic.

Motorola says that it has fabricated more than 100 different types of custom-designed multiple-chip semiconductor microcircuits, both linear and digital types, for more than 30 different customers in recent months. The company demonstrated a small 120 mc transceiver, developed under Air Force sponsorship, using the multiple-chip microcircuits. Company also reports that it has built a two-stage single-chip microcircuit linear amplifier which exhibits more than 20 db gain over the frequency range from several hundred kilocycles to 50 megacycles.

The multiple-chip microcircuit can be used for low-quantity custom-design applications, or as an interim step toward a single-chip semiconductor microcircuit, where quantities justify the tooling cost.

In fabricating a multiple-chip microcircuit, Motorola has used as many as 20 individual chips, each containing a transistor or an appropriate network of semiconductor resistors, in a single TO-5 package. Connections are made by tiny wires which are thermally bonded to appropriate chips. In effect, this multiple-chip microcircuit is a discrete-component type in which all components are fabricated from semiconductor materials, each on a tiny chip.

There is no reason why a tiny non-semiconductor component could not be used if required, providing there was room for it in the package.

Motorola plans to build up a stock of chips containing different types of transistors and resistors so that it can quickly fabricate a multiple-chip microcircuit. Company has built a semi-automatic machine for handling and placing the chips on the TO-5 header. A spokesman reports that company has orders for more than 10,000 units of one of its multiple-chip circuits.

For fabrication of a complete microcircuit on a single semiconductor chip, Motorola has developed new technique which permits it to fabricate a number of transistors and resistors on a single semiconductor substrate with isolation between the individual components.

Double Diffusion

In the new process, either N-type or P-type semiconductor material is diffused into the substrate after which an epitaxial layer is grown over the diffused areas. During epitaxial growth and later heat treatments, the material originally diffused into the substrate diffuses back into the epitaxial layer. Motorola says it has grown as many as 16 N-P layers on a single crystal by this double-diffusion process.

This diffusion technique permits isolation of individual components as well as providing low-conduction paths which can serve as buried interconnections between components on the substrate, if desired. The technique also provides greater flexibility in the fabrication of the active elements to achieve a greater range of operating characteristics.

Motorola says that present techniques require a minimum of a month, to produce a single-chip semiconductor microcircuit after the basic circuit design has been worked out.

U.S., U.K. Set Clocks Via Telstar Satellite

Washington—Master clock of the U.S. Naval Observatory in Washington was synchronized with the master clock of the British Royal Greenwich Observatory to within 10 microseconds, roughly 100 times the accuracy previously possible, by means of the Telstar communication satellite on Aug. 25. This was the first time such synchronization has been accomplished by satellite.

The improved synchronization will facilitate experiments and studies of the propagation of radio waves at high and very low frequencies. It also will be used to check the accuracy of the timing clock to be carried by the Navy's Transit navigational satellite.

To carry out the synchronization experiment, the American Telephone & Telegraph Co. station at Andover Me., and the British station at Goonhilly Downs each transmitted time marker pulses simultaneously, based on time determined from the master clock of its own national observatory. Each station recorded the instant of its own transmission and the instant it received the signal from the other. From these two measurements it is possible to determine the error in synchronization between the two master clocks.

The clock at the Andover station was synchronized to the Naval Observatory in Washington by means of transmissions from a Loran-C station at Nantucket, Mass., which is synchronized to the master Loran C station at Cape Fear, N.C., which in turn is controlled from the Naval Observatory.

Defense Clarifies Role Of WSEG Contractors

Washington—New rules intended to reassure military officers that the work of the Defense Department's Weapon Systems Evaluation Group (WSEG) will not be overshadowed by non-profit, civilian-dominated study organizations were published last week.

The move came after Army Lt. Gen. William P. Ennis, WSEG director, complained to his civilian superior, Dr. Harold Brown, director of defense research and engineering, that recent moves to have studies performed by the non-defense organizations would make WSEG only an advisory body that would not merit having a three-star officer at its head.

WSEG is made up of military officers and civilians.

Department of Defense Directive 5129.37, dated Aug. 23, places responsibility on the WSEG director for originating study contracts, monitoring them and coordinating them with other elements of the Office of the Secretary of Defense, such as the Joint Chiefs of Staff.

Principal target of Gen. Ennis was the Institute for Defense Analyses, a non-profit organization sponsored by nine of the nation's universities. IDA has been making studies for WSEG since 1956. Other contractors also have participated. Until the new rules were issued, studies furnished by these contractors were not separately identified by final WSEG reports. Now they will be.

Generally speaking, a WSEG study is an operational analysis or evaluation which makes use of contractor reports, reports of the WSEG staff and reports from other elements of the secretary's office. Most of the study efforts originate through discussions with the Joint Staff.

Section 7.C of the directive specifically states that the WSEG director will arrange for participation of military personnel when a study task is assigned to an outside contractor.

The directive also emphasizes internal review and consultation with the Joint Staff.

Senate Unit Restores Some NASA Funds

Washington—Senate appropriations committee last week restored $60 million of the $143 million cut by the House from the National Aeronautics and Space Administration's Fiscal 1963 budget request.

The committee also indicated it would look favorably upon requests next year for supplemental funds. NASA officials already have told congressional leaders that they will need more money than requested to carry out their Fiscal 1963 program. A supplemental appropriations request most likely will be made (see p. 16).

All told the Senate committee recommended giving NASA $3,704,115,000 for Fiscal 1963. This compares with the original NASA request for $3,787,276,000 and the House appropriation of $3,644,115,000 (AW Aug. 6, p. 37). Rather than go into conference this late in the session, the House probably will accept the Senate bill.

Of the $60-million restoration, the Senate committee voted $40 million for research and $20 million for facilities construction. It said that if more research funds are required, "a supplemental estimate can be considered early next year."

The committee also voted $530,000 for the National Aeronautics and Space Council—the same amount as the House approved and $15,000 less than President Kennedy requested.

News Digest

Douglas Aircraft Co. will use a new facility in Huntington Beach, Calif., for design, assembly and test of the NASA S-4B hydrogen fueled Saturn upper stage starting next year. Development of the stage is under way in Santa Monica where construction of the stage and sub-assemblies will continue. Huntington Beach plant will be headed by Robert L. Johnson.

SAAC 23 Lear-Jet executive transport has gained its first U.S. distributor. Yingling Aircraft, a Cessna dealer. Yingling will market the aircraft in the Dakotas, Nebraska, Colorado, New Mexico, Kansas, Oklahoma, Texas and part of Missouri and will continue handling Cessna aircraft as well.

Aerojet-General's Space Propulsion Division reports a several-minute test of a variable-thrust, ablative chamber rocket engine in which the thrust was varied from 2,200 lb. to 0 lb. Test included two re-starts and used nitrogen tetroxide and Aerojet's Aerozine/50 as propellants.

New missile for the British army, designated Tigercat, is being developed at Belfast by Short Brothers & Harland.

Chance Vought Corp. has been awarded a $47.4-million Navy contract for 45 F8U-2NE fighter aircraft, an add-on to a previous $120-million order for more than 100 of the aircraft. This version of the Crusader is being adapted for limited war and counter-insurgency missions.

Japan's YS-11 medium range turboprop transport made its first flight last week. Plane is scheduled to enter production next year, according to manufacturer, Nihon Aeroplane Manufacturing Co.

Rolls-Royce Aero Engine Division last week said it will take over production and follow-on development of the Napier Gazelle gas turbine helicopter engine from Napier Aero Engines, Ltd., a subsidiary of Rolls and English Electric Co. Immediate effect is lay-off of 2,500 employes at Napier, where the Gazelle is the only engine being manufactured.

John Stack, vice president and director of engineering at Republic Aviation Corp., will receive the 1962 Wright Brothers Memorial Trophy for "major contributions to aeronautical research, and for his leadership and vision in aeronautics." The trophy will be presented Dec. 17 in Washington, D.C.

Shield Sought for Vertol Engine Intake

Parts ingestion causes engine failure in New York and Japan; New York Airways alters overland route.

By James R. Ashlock

New York—Research has been speeded up by Vertol Division of the Boeing Co. toward development of an engine intake shield that will prevent foreign matter ingestion like that which caused three forced landings of Vertol 107 helicopters in little over a month.

Two of the incidents involved Vertols used by New York Airways. The third occurred in Japan last week during a Vertol demonstration by Kawasaki Aircraft Co., Ltd., Japanese sales agency for the turbine-powered helicopters.

The latest New York Airways accident occurred Sunday, Aug. 26, when a Vertol 107 lost one engine due to ingestion of fragments from a torn rubber rain cover boot on the forward cowling. None of the 25 passengers and three crew members aboard was injured in the water landing near a Brooklyn Navy Yard pier.

In a similar incident, another New York Airways Vertol landed in New York harbor July 16 after both engines ingested parts of a fractured maintenance door on the forward rotor transmission cowling (AW July 23, p. 33).

Early reports on the forced landing in Japan said one engine ingested a cam lock fastener which came loose near the front end of the drive shaft to the forward rotor. No injuries were suffered by the 25 passengers aboard, reports said.

Vertol officials said several intake shield designs, including air flow deflectors, are under consideration. However, final determination still awaits full flight testing.

"We have our engineers working day and night on the problem, and we expect a solution shortly," said an assistant to Don R. Berlin, Vertol vice president and general manager.

John E. Gallagher, vice president of New York Airways, said his company expects to install the shield as soon as Vertol and the FAA agree on an acceptable model. In the interim, New York Airways is temporarily altering one of its longer overland flight legs to provide more overwater routing in the metropolitan area.

The land segment being eliminated is a 6-mi. stretch over Brooklyn, Gallagher said, which normally is flown between 800-1,000 ft. altitude. The 107 could safely make it to water from any point of this segment with one engine out, even on hot days and with a maximum payload, Gallagher said. However, in view of the second forced landing, the Vertols will now fly a coastal route around Brooklyn to Idlewild for the next two weeks while work continues toward developing the engine intake shield.

The only public clamor over the two New York Airways incidents has been raised by Rep. Hugh L. Carey, Democrat from Brooklyn, who requested that helicopter flights over the metropolitan area be restricted to water routes.

However, no federal action that would restrict New York Airways' operations beyond the voluntary action already taken is contemplated by Federal Aviation Agency or Civil Aeronautics Board, spokesmen said.

Besides changing the Brooklyn route, New York Airways has also removed the rubber rain cover boots around the forward rotor. The boots surround and fluctuate with the three pitch link rods connected to the rotor blades and provide weatherproofing for the three 5 x 8-in. openings through which the rotor links extend. The rubber tears frequently, evidently due to slipstream exposure, New York Airways officials said. CAB has not expressed an opinion on the boot failures.

Tearing on all three boots was evident in a post-accident inspection. A hand-sized portion was ripped out of one, and is believed to be the piece ingested by the starboard General Electric CT58-110 engine, mounted beside a companion powerplant 23 ft. behind the forward rotor shaft housing.

After dismantling the engines at a Linden, N. J., maintenance facility, the CAB reported that rubber fragments were jammed between the starboard engine's second stage stator blades and the engine casing. This stalled the engine's compressors, CAB said.

FAA endorsed New York Airways' temporary removal of the boots, even though their absence restricts the Vertol's operation in heavy rain. The carrier said the boots can be reinstalled for brief periods during rainy weather to avoid schedule disruption.

Gallagher said the Vertol was operating under temperature conditions and with a load that prevented its maintaining altitude on one engine when the latest incident occurred.

Outside air temperature was 80F and the Vertol's gross load was 18,941 lb., just 59 lb. short of its gross limit. Vertol's operations manual indicated that under such conditions, rate of sink will be 100-200 fpm. on one engine. Figures show that the Vertol could have stayed up with 16 passengers aboard, figuring 200 lb. per person including luggage. But with its full load, air temperature would have had to be no higher than 66F for single-engine flight.

The landing occurred at 3:38 p.m. Aug. 26, nine minutes after the flight, No. 424, departed Newark on a non-stop run to Idlewild. In command was Capt. Howard Higgins, 47, a 10-year employe of New York Airways with 11,000 hr. of rotor aircraft time. Jack Compton, a line captain with 8,000 rotor hr., was co-pilot.

Higgins' first indication of trouble was a rapid rise in temperature on the starboard engine while cruising at 800 ft. He decided to shut down the engine and land near the pier, which was equipped with a heavy lifting crane and was surrounded by calm water. During descent, Higgins flew a wide circle to set up his landing pattern, then settled 50 ft. from the pier. Boats towed the helicopter to the dock.

Two of the forward rotor blades, which cost $8,000 each, were damaged as a result of being tied down to moor the helicopter. There was also some water leakage around service tabs on the Vertol's sponsons, 2.3 m. accumulating in each sponson. About 3 m. of water seeped into the bottom of the baggage compartment, but luggage remained dry.

The helicopter was in the water 1 hr. 47 min. before it was hoisted by a Navy crane and placed on a barge for transport to New York Airways' base at La Guardia. Serial number of the aircraft is 6675 D. It was the first of New York Airways' three Vertols to be delivered.

Referring to the July 16 forced landing, Gallagher said modifications had been made to prevent inadvertent opening of the maintenance door which fractured after springing open during flight. A fail-safe type latch has been installed and safety wires attached.

Gallagher said the incidents have influenced thinking toward New York Airways planned operation from the roof of the 80-story Pan American building still under construction in downtown New York, although the carrier has not altered its basic planning for the operation.

"We have never contemplated the rooftop operation with the current engines which have a 1,250-shp. rating," Gallagher said.

He said GE is modifying the CT58-110 to give a rating of 1,400 shp., and this engine should be available toward the end of this year.

"We figure that with 1,400 shp. engines, we'll have single-engine performance providing 150-fpm. climb even with an 18,000-lb. gross load and 89F air temperature," Gallagher said. "That would give us the margin needed for operation from the Pan Am roof."

Aside from the ingestion problem, Gallagher said New York Airways has few problems with the CT58-110 although some engines have been pulled for maintenance ahead of schedule.

Frequency Reduction

New York—Charles C. Tillinghast, Jr., president of Trans World Airlines, has met with C. R. Smith, president of American Airlines, and W. A. Patterson, president of United Air Lines, for discussion about mutual reduction of transcontinental jet frequencies.

Tillinghast initiated the discussions as an approach to easing the over-capacity problem affecting the three carriers. He feels such a move would provide more return on available passenger volumes, and at the same time would release jets now used on transcontinental runs for use on segments now flown with piston equipment.

A meeting of all three presidents together has not been held, but both Patterson and Smith are reported interested in Tillinghast's proposal.

NEW YORK AIRWAYS BOEING-VERTOL 107 is lifted from the East River at Brooklyn Navy Yard after making a forced landing due to failure of one of the two General Electric CT58-110 turbine engines. Failure was blamed on ingestion of failed rubber rain cover boots. Accident was the third of the same kind in recent weeks.

Traffic Figures Raise Hopes on Load Factors

Washington—Analysis of domestic trunkline traffic for the past six months indicates that airline business may be on the upswing, despite an average industry load factor that has hit a new and dangerous low.

There is little question among most airline officials that the steady decline in load factors, which began in 1959, reflects the introduction of large fleets of jet transports on high density trunkline routes. Seat capacity has soared and, until recent months, has regularly outstripped the growth in revenue passenger miles.

Now, however, there are signs that a renewed traffic growth trend may be sufficient to offset the continuing rise in available seat miles and restore the load factor to a healthier mark. This is borne out by a study of the load factor for domestic trunklines during the past five months.

Industry load factor in March was 52.2%, a decline of 5.1 percentage points from the March 1961 level. In April, the industry load factor fell 4.6 points from the level reached the previous April. In May, the decline was 3.3 points and, in June, 2.3 points. A slight increase was recorded in July, but this can be attributed to the Eastern Air Lines strike.

These changes indicate a closure rate of about one point a month. Although it is too early to tell whether the rate will be maintained, the trend is raising hopes for the over-all 1962 load factor picture.

In the first half of 1961, load factors showed a small increase in February and March but then began a steady decline that was not arrested until December. The load factor drop in April was 2.5 points, 4.3 points in May and 5.6 points in June. By July, the difference had climbed to 6.2 points. Therefore, load factor activity in the first six months of 1962 has reversed the trend shown in the first half of 1961.

727 Engine Tests

Federal Aviation Agency certification testing has begun on the Pratt & Whitney JT8D turbofan engine which will power the Boeing 727 jet transport. Certification of the 14,000-lb.-thrust engine is expected by the end of the year, coincident with start of 727 flight tests.

The engine has already undergone 4,000 hr. of development tests, including 40 hr. aloft in a flying testbed. P&W has used 11 of the engines in tests to date, one of them logging 750 hr. of running time.

Traffic Lag, New Aircraft Blamed For $4.5-Million BEA Loss in 1961

London—British European Airways last week reported a loss of $4.5 million for the fiscal year ending Mar. 31, the first time in eight years that the state-owned airline has not shown a profit.

Primary reasons for the deficit, according to Lord Douglas of Kirtleside, BEA chairman, were:

- **Failure of domestic and European** traffic to expand in line with increased capacity made available.
- **Cost of buying and phasing in new** aircraft, such as the de Havilland Comet and Vickers Vanguard, and the Armstrong Whitworth Argosy and Handley Page Dart Herald.

Lord Douglas put Vanguard costs at about $6 million. Comet costs were set at about $280 million, the Argosy at $165,000 and the Herald at $30,000. To cut this loss, BEA drew $3 million from development reserves, as predicted by AVIATION WEEK (Aug. 6, p. 50).

Because of competitive pressure from other airlines serving London, Lord Douglas said BEA had to raise its jet capacity as much as possible, and brought seven more Comets into service during the year. Comet operations accounted for 24% of the traffic.

Concerning traffic, Lord Douglas warned that on the basis of present trends and projections, the problem of excess capacity in the European market will continue for several years. To combat this, BEA last week asked the Air Transport Licensing Board for permission to inaugurate no-reservation, walk-on services between London, Glasgow, Edinburgh and Belfast at a reduced rate.

The move probably will be strongly opposed by the state-owned British railways. BEA wants to start the service on an experimental basis from Apr. 1 to Oct. 31 with the lower fare on off-peak flights.

Lord Douglas pointed out that BEA's rate of traffic growth fell below expectations, although passenger traffic increased 11% over the previous year. Over-all load factor, however, fell from 65.2% to 59.9%.

Because of this drop, Lord Douglas said it would be stupid and wasteful to allow more airlines to provide even more capacity in Europe at the present time. This was a reference to an ATLB award of 22 competitive routes awarded to British United Airways and Cunard Eagle Airways, two largest British independents (AW Dec. 4, p. 41). Decisions on a BEA appeal are still being awaited.

Looking to BEA's future, Lord Douglas cited these points:

- **New de Havilland Trident** three-jet transport will be delivered earlier than expected, probably by next July, and may go into limited service by December, 1963. BEA has ordered 24, but the chairman said final decision on the route appeals probably will dictate BEA's interest in follow-on orders and further Trident developments.
- **BEA will not go** into the charter business with its Viscount 701 transports, although the matter has been considered.
- **Airline is still examining** possibilities of buying one or two Vertol 107 helicopters for development studies and possible scheduled operations between Lands End and the Scilles. Lord Douglas said discussions are under way with Ministry of Aviation but noted BEA could not operate the services without financial support from the government.
- **BEA considers** that airlines would be unwise to allow themselves to be rushed into buying supersonic transports and says supersonic transport uses rule out most of its short-to-medium range routes.
- **Comet utilization** will be boosted next year to an annual rate of 2,800 hr., compared with 2,042 hr. experienced in 1961-62.
- **Airline foresees no requirement** for use of the BAC 111 twin-jet transport at the present time, and prefers to leave the hovercraft and car-ferry field to British independent operators.

Lord Douglas, whose appointment as BEA chairman expires in December, 1963, said there was no chance that the airline would join Air Union, even if Britain enters the Common Market, and deprecated the possibility of a merger with British Overseas Airways Corp., the other state-owned airline.

ESTIMATED AEROFLOT FLEET	
Turbo-jets	
TU-104 (all series)	130
Turbo-props	
TU-114	5
IL-18	60
AN-10/10A	25
Total Turbo Engined Aircraft	220
Piston-engined	
IL-12, IL-14, LI-2, AN-2	1,600
Total Fleet	1,820

Recent figures indicate size, make up of Soviet transport fleet

FAA Budget Slashes Restored in Senate

Washington—Senate appropriations committee last week restored $46.4 million of a $70 million cut voted earlier by the House for the Federal Aviation Agency's Fiscal 1963 budget request (AW Aug. 6, p. 45).

Need to improve the air traffic control system and continue with a program for development of a supersonic transport was emphasized in the Senate committee increases, which included $25 million for operation and staffing of air traffic control facilities; $10 million for the purchase of new ATC equipment and $10 million for the supersonic transport program.

Total budget approved by the committee is $786 million, compared with the House total of $739.6 million and the FAA's request for $810.8 million.

The committee emphasized that FAA should economize in its operations wherever possible and suggested that it might often be less costly to lease aircraft from scheduled or non-scheduled operators than to operate its own aircraft.

Balance of the Senate increase was accounted for by a $400,000 addition for new construction at Dulles International Airport and $500,000 increases in the operations and maintenance budgets of both Dulles and Washington National Airport. The Dulles money will permit complete funding of a two-bay hangar and related facilities needed for scheduled trunkline services.

Civil Aeronautics Board's budget request, cut nearly $13 million by a House appropriations committee, was also increased $11.6 million by the Senate committee, for a Fiscal 1963 budget approval of $92.4 million, compared with CAB's requested budget of $94.4 million.

More than $11.1 million of the increase covers CAB subsidy requirements. The committee said these may be expected to decrease under present CAB procedures. To aid in the future reduction of subsidy, the committee recommended that CAB develop a program under which it could lease or purchase a limited number of aircraft which it believes capable of operating more economically than aircraft currently being used by local service airlines. These could be provided on an experimental basis to the local service lines as an actual test of which type of aircraft may require the least subsidy.

Anticipating the possibility that CAB may certificate a fourth subsidized helicopter operation, the committee also restored $875,000 cut from the helicopter subsidy limitations by the House.

Telstar Relay

New York—Trans World Airlines President Charles C. Tillinghast, Jr., last week completed the first passenger radio-telephone call to Europe from an airborne jet transport via American Telephone & Telegraph Corp.'s Telstar communications satellite (see p. 27).

Tillinghast called Lord William Mabane, chairman of the British Travel Assn., in his London office, Aug. 29 and spoke for five minutes to demonstrate the possibilities of future radio-telephone communications for passengers flying anywhere in the world.

Tillinghast spoke from 31,000 ft. over Lewiston, Pa.

The call was transmitted to a Bell System airborne radio ground station in New York, routed to Andover, Me., relayed to Telstar, received by the Goonhilly station in southwest England and routed to Lord Mabane's office in London.

The radio telephone was installed about seven weeks ago in a TWA Convair 880 (AW July 30, p. 34) to test passenger acceptance of the system.

Probe May Postpone New Dallas Runway

Dallas—Start of construction on a new 8,000-ft. parallel instrument runway at Love Field here probably will be postponed indefinitely pending outcome of Civil Aeronautics Board's investigation of supporting scheduled airline service at both Love and nearby Amon Carter Field.

Civic officials here emphasize that the present contract with a San Antonio construction firm has not been canceled. They termed a recent statement by Dallas Mayor Earle Cabell—that remarks by Federal Aviation Agency Administrator Najeeb Halaby (AW Aug. 20, p. 50) and notice by CAB of its investigation of the situation have made plans for the new runway a dead issue—as being stronger than Cabell actually intended to say.

However a work order that was to have been issued by the city authorizing the contractor to begin construction two weeks ago is still being withheld, and there was no indication last week that it would be released.

A CAB staff member indicated that the Board might cancel its investigation if Ft. Worth and Dallas civic leaders form committees to study possibilities of developing a regional airport jointly serving both communities.

Cabell said that conversations he had held with the mayor of Ft. Worth show that there would be little merit in establishing such a committee.

Eastern Personnel Force Cutback Could Prove to Be Merger Benefit

New York—Eastern Air Lines will not rehire 4,000 of the 17,000 employes who were on its payroll before the June 23 strike of the carrier's flight engineers, a factor that would benefit Eastern in event of its merger with American Airlines.

The smaller employe force is part of Eastern's over-all reduction pattern, which includes a decision not to resume some service to points outside major markets, plus retirement of its 34-plane Martin twin-engine fleet.

The subject of employe displacement by an American-Eastern merger stirred labor union unrest when talks between the two carriers first became known. But the 13,000 member force Eastern plans to continue with would most likely be totally absorbed in event of merger, eliminating much of the labor settlement problems that usually accompany such moves.

One of the unions to feel the cutback most is the International Assn. of Machinists. Approximately 1,200 of its 3,000 members at Eastern's Miami installation will not be recalled.

IAM spokesmen expressed disappointment at the announcement, but said that it was within the company's rights according to the IAM contract to determine the size of its maintenance force.

The IAM indicated no plans to take any action against Eastern as a result of the cutback. The union had only recently agreed with Eastern (AW Aug. 27, p. 45) about the pattern by which members of the union would be recalled during the airline's resumption of service.

Eastern is continuing its efforts to restore full jet and piston service, according to its revised pattern, by Sept. 13. The program was accelerated last week with resumption of air shuttle service from Newark Airport to Washington and Boston. It had not been planned earlier to restore this service before Sept. 13.

Expansion of the shuttle operation, which had already been reactivated from La Guardia Airport, was made possible by availability of flight engineers and returning IAM employes.

Eastern was also granted a $1 increase in Air Shuttle fares by the CAB last week, raising the New York-Boston fare to $14 and the New York-Washington to $16. The airline attributed "newly incurred higher operating costs" as the reason for the increase.

Malcolm A. McIntyre, Eastern president, said that well over 10% of the airline's striking engineers had responded to Eastern's return-to-work contract offer, indicating a number in excess of 60.

In addition, 76 pilot trainees had completed their Federal Aviation Agency certification for pilot-engineer duties by last week, and an estimated 30 more who already had flight engineer tickets had completed their flight checks.

The Flight Engineers International Assn. is continuing its efforts to block Eastern's recovery through court actions. The latest occurrence on this front came last week from Federal Judge Richard Levet in New York, who reserved decision on an FEIA motion that would enjoin Eastern from assigning flight engineers except as provided in the expired FEIA contract.

The FEIA has also sought to halt Eastern from assisting any labor organization to displace the FFIA as the representative of Eastern's flight engineers, alluding to the carrier's talks with the Air Line Pilots Assn. Judge Levet also took this matter under advisement.

Overtures have been made to Eastern's FEIA membership by the Teamsters Union relative to transfer of bargaining representation. The Teamsters also loaned FEIA $100,000 for support in the latter's strike against Eastern. The Teamsters have also approached the flight engineers of Northwest Airlines with a proposal similar to that offered Eastern's engineers.

Halaby Supports Local Airlines on Overhaul

Washington—Local service airlines' income from maintenance and overhaul contracts was cited by Federal Aviation Agency Administrator N. E. Halaby last week as the type of non-transport activity which should be permitted by the Civil Aeronautics Board.

Appealing on behalf of the local service operators, Halaby told CAB Chairman Alan S. Boyd that pending Board regulation changes, designed to prohibit any non-transport activity by subsidized airlines, could result in the closing of repair stations already authorized under Civil Air Regulations and termination of maintenance and overhaul work done by the local operators for each other.

Halaby contended that the maintenance and overhaul work has generally contributed to air safety and should not be subject to any CAB limitations.

USSR-Japan Carrier Opposition

Proposal to create a new Japanese airline to operate between Tokyo and Khabarovsk, Soviet Union, where it would link with Aeroflot for service to Siberian cities and Moscow (AW May 28, p. 49), is running into opposition from the Japanese government and Japan Air Lines.

Tokutaro Kitamura, president of an influential Japanese trade association, proposes formation of a joint venture involving Japanese airlines and trading companies to enter into an airline agreement with the Soviet government.

This company would charter Japanese aircraft to fly to Khabarovsk and return, with Russian pilots and aircraft providing connecting service between Siberian cities and Moscow. The Soviet government, which supports the proposal, does not permit foreign airlines to fly over Siberia for security reasons.

Japanese government is against the proposal because it feels any Tokyo-Moscow route must be accomplished through a bilateral agreement. Japan Air Lines, which is controlled by the government, is also opposed to the new carrier.

At present, Japan has no air routes to the Soviet Union. A Japanese traveler desiring to visit the Soviet Union must first fly to Europe, then to Russia.

British Pilot, Navigator Guild Hits Heathrow Anti-Noise Procedures

London—British Guild of Air Pilots and Air Navigators last week made strong objections to noise abatement rules at London-Heathrow Airport, on the grounds the rules force jet transport pilots to fly too close to safety limits.

The guild cited two takeoff crashes, a BEA Comet at Ankara, Turkey, last December, killing 27, and an American Airlines Boeing 707 at Idlewild last March, killing 97, as a basis to doubt the wisdom of noise abatement rules.

The report, prepared by the guild's Flight Safety Committee, stressed that jet pilots must not be expected to tax their skill or the performance of their aircraft merely to reduce noise by a few decibels.

In the case of turboprop aircraft, the guild pointed out that pilots of Vickers Viscounts and Vanguards are expected to maintain an airspeed of 40 kt. lower than normal climb until passing 1,500 ft. The report suggests:

- Aircraft's climb attitude should not be steeper than required to maintain minimum climb speed with one engine out.
- Engines should not be throttled back beyond normal climb power until adequate safety height is reached.
- Aircraft should not be required to start a turn until it has reached at least 1,000 ft. altitude after takeoff.

Pilot Objection

The pilots object to present noise rule limitations at London because of the exaggerated attitude of the aircraft in a steep climb and inadequacy of flight instruments to maintain this attitude with certainty or accuracy. Other points include:

- Risk of fuel starvation when carrying light fuel loads.
- Proximity of airspeed to stalling speed at this steep angle of climb.
- Problem of engine failure while in an exaggerated climb angle.
- Danger of turns at low altitudes and low speeds.

Guild Stand

Guild stand on the noise rules portends another drawn-out fight involving London Airport-area residents, most of whom are represented by the Noise Abatement Society, a group which referred to the report as blackmail.

However, British Air Line Pilots Assn. has called an all day forum on the noise problem for Oct. 31, in which operators, manufacturers, crews and interested members of the public can state their views.

FAA Asks New Rules For Supplementals

Washington—Supplemental airlines, already under close scrutiny from the Civil Aeronautics Board now face the prospect of strict new operating regulations which have been proposed by the Federal Aviation Agency (AW Aug. 27, p. 38).

Before the end of this year FAA expects to adopt a series of regulation revisions that will have the effect of applying and enforcing the same safety standards to both scheduled and non-scheduled airlines.

Proposed changes are aimed primarily at ensuring that the supplementals maintain a high degree of safe maintenance and operational practices, under the direction of personnel meeting a set of minimum standards for qualification by the FAA.

One major change being considered would give FAA authority to examine financial records of a commercial operator in the course of evaluating the airline's safety of operations.

As a means of assuring that airline personnel are properly qualified to handle their responsibilities, FAA wants to establish minimum standards for the positions of director of operations, chief pilot, director of maintenance and airworthiness and director of quality control.

Each non-scheduled operator also would be required to establish an approved dispatch system or an approved flight following service, with the carrier's operations specifications stating which system would be authorized by the FAA.

Revision of the regulations covering supplemental and commercial operators has been under way since 1954.

Pilot Shortage Cuts Mohawk Flights

New York—Pilot shortage, caused largely by prolonged bad weather in August which exhausted crew time through Air Traffic Control delays, resulted in Mohawk Airlines canceling up to 50% of its 116 daily schedules last week.

The local service carrier, which began canceling flights Monday, was not able to restore full operations until Friday, when 10 pilots became available. They had just completed six weeks of training qualifying them to fly any of Mohawk's Martin 404 and Convair 240 or 440 aircraft.

Mohawk employs slightly over 200 pilots, but a spokesman said this force likely will be expanded to avoid recurrence of the shortage. He said a number of the pilots were not certificated on all three types of planes flown by Mohawk, and it was decided to put some of them through transition training during the anticipated good-weather period of July and August.

"But August turned into a wet, cloudy month," a Mohawk spokesman said, "and the traffic delays ate up the time of the reduced force still on the line."

He said the problem was complicated by the recall of a number of Eastern pilots who flew for Mohawk during the Eastern strike. Mohawk had counted on availability of these pilots through August.

The spokesman said there was no connection between the pilot shortage and Mohawk's prolonged negotiation with its Air Line Pilots Assn. members for a contract to replace the one that expired last year.

Hawaiian Carriers Dispute Route Pattern

Washington—Two Hawaiian scheduled airlines, traditionally bitter rivals are again in dispute over whether Hawaii's inter-island route pattern should be readjusted to reduce competition between the two carriers.

The latest controversy arose from a Civil Aeronautics Board order, issued last month, that calls for an investigation of Hawaii's air services. Aloha Airlines reacted promptly and sharply. In a motion petitioning postponement of the investigation, Aloha charged the CAB with using statements that were damaging to the airline and accused the Board of basing the investigation order on facts that are "stale, incomplete and misleading."

Hawaiian Airlines, on the other hand, accepted the Board order calmly and filed no response to it. Aloha's real fear, and Hawaiian's real hope, is that the investigation will lead to a recommendation that the two carriers merge in the public interest.

However, the Board said in its order that it does not intend to reverse an earlier finding that two carrier competition is justified.

Subsidy Estimate

The Board launched its investigation because it estimated that temporary subsidy requirements for the two airlines together for 1961 will total $570,000, and that future subsidy claims may reach or exceed $2 million. The Board added that such subsidy is "difficult if not impossible" to accept in a market that has no surface competition and has achieved a healthy volume of air traffic.

The Board order, however, did say that the investigation is being instituted to determine whether the certificates of the two carriers should be "altered, amended, modified or suspended." This leaves the door open for the establishment of a single carrier service on some, if not all, routes.

Hawaiian Airlines has long been interested in merging Aloha into its system. Aloha has consistently resisted such moves. It wants to retain the status quo—a route system that duplicates and parallels Hawaiian's system throughout the Hawaiian Islands.

In its motion for deferral of the investigation, Aloha voiced full optimism over the future of the two carriers and said that current figures "show a more favorable picture than that on which the Board based its action in ordering an investigation. Moreover, continuing growth in the Hawaiian market will present the carriers with opportunities to improve operations in the next two years."

Aloha took issue with these three assertions made by the CAB in its order:

- That Hawaiian carriers should be making profits now.
- That side-by-side competition is the cause of high costs.
- That promotion and sales expenses and general and administrative costs of the Hawaiian carriers are too high.

Aloha said these statements were erroneous and could damage public confidence in Hawaiian air service. It said that the press and the public would imply from these statements that Hawaii's airlines do not know their business and added that, if the investigation goes on, Aloha "stands unfairly condemned in the eyes of many passengers it now serves."

Hawaiian Airlines took no official stand on these three issues, but one of its officials indicated the company supported the investigation, since the proceedings would help find ways to improve the economic conditions of the carriers without adversely affecting the public interest.

He added that Hawaiian has "nothing to hide," and said he felt "there is no better way to give service to our island public than by such an inquiry" into the need for a two-carrier system and into subsidy requirements.

Aloha charged that the Board should have used more up-to-date material as the basis of the order. For example, it said, the high general and administrative cost figures that the Board complained of were caused in large part by the stiff Hawaiian fuel taxes which, since the Board compiled its figures, have been lowered.

The airline also said that a third of its general and administrative funds went directly to the state for gross receipts tax. If this adjustment is made in total figures, Aloha said, its 1961 ratio of general and administrative expense to total transport revenues is almost identical to that of Mohawk's—which the Board uses as a basis of comparison—despite Aloha's smaller total operation.

With respect to high costs, Aloha explained that conditions in Hawaii require high costs in some categories and permit economies in others. It then noted that Aloha leads the entire local carrier field in passengers served per subsidy dollar.

The airline said that remoteness from the mainland boosts costs of most items needed to operate an airline and also requires higher stocking of parts. Extra operational requirements on overwater flights add to Aloha's flight expenses, the carrier said.

Higher Costs

It noted that Aloha has the fewest route miles of any fixed-wing U.S. carrier, which forces per mile costs upward, and added that the average haul on intra-Hawaiian routes is only 150 mi., compared with 209.3 mi. for Allegheny and 203.9 mi. for Mohawk.

Aloha, in its motion, took sharp issue with plans to reduce routes in the state. Any change in the route pattern, the airline said would "tighten the operational strait jacket" on both carriers by reducing the already small route structure. Smaller routes would reduce opportunities to obtain maximum utilization of equipment and to operate efficient schedules.

Aloha mentioned that two-carrier competition in Hawaii had been endorsed and reaffirmed in earlier CAB cases and said that, by law and policy, the Board is committed to such an operation. It said that previous cases had proved that a subsidy-free Hawaiian air service was bought at the price of inadequate service and high rates. This was undoubtedly a reference to the years before 1949, when Hawaiian was the only airline serving the islands.

Aloha said in its conclusions that if the investigation is to be held, it should encompass the effects of air taxi operations on certificated island carriers (AW Aug. 6, p. 50). It charged that Hawaiian Air Tour Service competes with Aloha for tourist and sightseeing business and added:

Aloha contends that a useful examination of the ways to reduce or eliminate subsidy in Hawaii must include the question of how much authority should be allowed air taxi operators and what actual inroads Hawaiian Air Tour Service has made on certificated carriers."

Viscount Equipment

United Air Lines apparently plans to keep the Viscounts inherited through the Capital Airlines merger in operation for some time, as evidenced by a $600,000 investment in transponders and distance measuring equipment for the turboprop aircraft.

Installations have begun at United's Washington maintenance facility. Transponders will be in all the Viscounts by October and the DME by December 30, United says. The airline has already placed the equipment on its DC-8, Boeing 720 and Caravelle aircraft.

United says the transponders are the latest type, adaptable to the "third dimension" automatic altitude reporting system undergoing development by FAA.

AIRLINE OBSERVER

► Pan American World Airways may end service to Havana—last U S air link with Cuba—unless the airline gets government help to offset losses on the route. Pan American says it has lost over $5 million on service between Miami and Havana since March, 1961. It also has over 2 5 million Cuban pesos—fare money—frozen in Cuban banks. Pan American says several U S government agencies have urged that the service be continued but none has offered any monetary help. Usual service pattern of Pan American's daily DC-6 flight is deadhead to Havana and a full passenger load of refugees on return.

► **Early indications are that trunkline passenger traffic for August will show a substantial increase over the same period last year. Prospects now are that an 11% increase in revenue passenger miles will be recorded for 1962, after two years of near stagnation.**

► U S flag carriers' sales personnel are discouraged over performance of the government's American Travel Service staff in Europe. Major complaint of the airlines is that ATS representatives are inexperienced, are not effective promoters and are not adept in handling the foreign press, which continues to ridicule the idea that Europeans may travel economically in the U S.

► **Delta Air Lines has reported a record net income of $2,082,000 for the month of July. Operating revenues of $19,372,000 for the month were 59% above those for the same month last year. Operating expenses in July totaled $14,557,000 for an increase of 22%. Delta's load factor for the month reached 66.76%, compared with 55 31% for the same month last year.**

► Civil Aeronautics Board is broadening its planned investigation of South American air routes to include the Caribbean area and its position in relation to the routes served by Pan American World Airways· Pan American-Grace Airways, Delta Air Lines and Braniff Airways. The Board will proceed with its schedule on the South American service, adding evidence later on the Caribbean operations for a combined case.

► **British European Airways is attributing a Fiscal 1962 loss of $4,166,582 primarily to the failure of traffic growth to offset increased seat capacity offered. After forecasting an over-all traffic gain of 20% over its domestic and international routes, BEA realized a gain of only 9.2%. The airline also has denied rumors that it would join Air Union if Great Britain enters the Common Market. With its present control of a majority of the intra-European air traffic, BEA feels there would be no advantage to joining a larger airline consortium.**

► Southern Airways was told by the Civil Aeronautics Board last week that any agreement aimed at settling its 28-month-old pilots' strike must include complete seniority reinstatement for the strikers. The Board said it made this clarifying statement after the Air Line Pilots Assn. complained that Southern, in following a CAB order to "bargain in good faith" with the strikers, had attempted to place some of the non-union pilots hired during the strike higher in seniority than the reinstated pilots.

► **Air Congo's attempts to restore Leopoldville-Elisabethville service under United Nations' authority are being resisted by the Katanga government. When the first Air Congo flight arrived at Elisabethville, three European passengers were arrested and later expelled by Katangan authorities. In an earlier note of protest to the United Nations, Katanga had threatened to take such action to combat the "arbitrary decision" of the UN.**

► Continental Air Lines reports that weekend traffic on its major routes has increased more than 36 5% because of its new business class fare experiment (AW Aug 27, p 47). Continental flights providing the new service between Chicago and Los Angeles have been averaging 92 passengers, and the airline claims that its total revenue passenger miles registered a 17% over-all gain for the first three days of the experiment over the previous three weekends.

SHORTLINES

► **Allegheny Airlines** showed a 33% jump in cargo traffic in July over the same month a year ago. Allegheny said it carried 1,861,309 lb. last month.

► **American Airlines** will offer business and economy class fares on five daily round-trip flights between Chicago and Los Angeles, using Boeing 707 turbofan jets. The $85 economy fare represents a $20 reduction over current coach fares on the route.

► **British Overseas Airways Corp.**, announced that it carried 10,000 revenue passengers between New York and Bermuda in July. BOAC said this represented a 99% increase over July, 1961.

► **Mohawk Airlines** declared a net profit of $187,714 for the first half of 1962. The airline blamed the drop from $257,522 for the same period last year on increased operating costs, installation of a Univac computer reservation system, and pilot training costs associated with the line's Convair and Martin equipment.

► **Northwest Orient Airlines** showed a net profit after taxes of $1,077,617 for July. This represented an increase of almost 100% over the same period last year. Net profit for the January-July period totaled $2,989,524, compared with $1,830,315 a year ago.

► **Pacific Northern Airlines** credits a record 71 980 passenger boardings during July to a brighter Alaskan economic picture and an extended tourist season that brought visitors to the 49th state earlier than usual.

► **Pan American World Airways** will replace Douglas DC-6Bs on its Caribbean routes, linking Miami, Montego Bay, Kingston, Santo Domingo, and Puerto Rico, with Boeing jet aircraft in September.

► **Trans Texas Airways'** 35,439 passenger boardings in July represented a 38.73% increase over July of 1961. TTA said it surpassed all other U. S. airlines in July by recording a 91 1% on-time factor in the five-state area it services.

► **Trans World Airlines** will operate 42 weekly round trip jet flights on its North Atlantic routes this winter—18 more than it operated last winter. TWA also plans its first winter jet polar flights from the West Coast to Paris, Milan, and Rome.

?

Who'll take most of the growing airfreight business?

Airfreight business is going one way: UP!

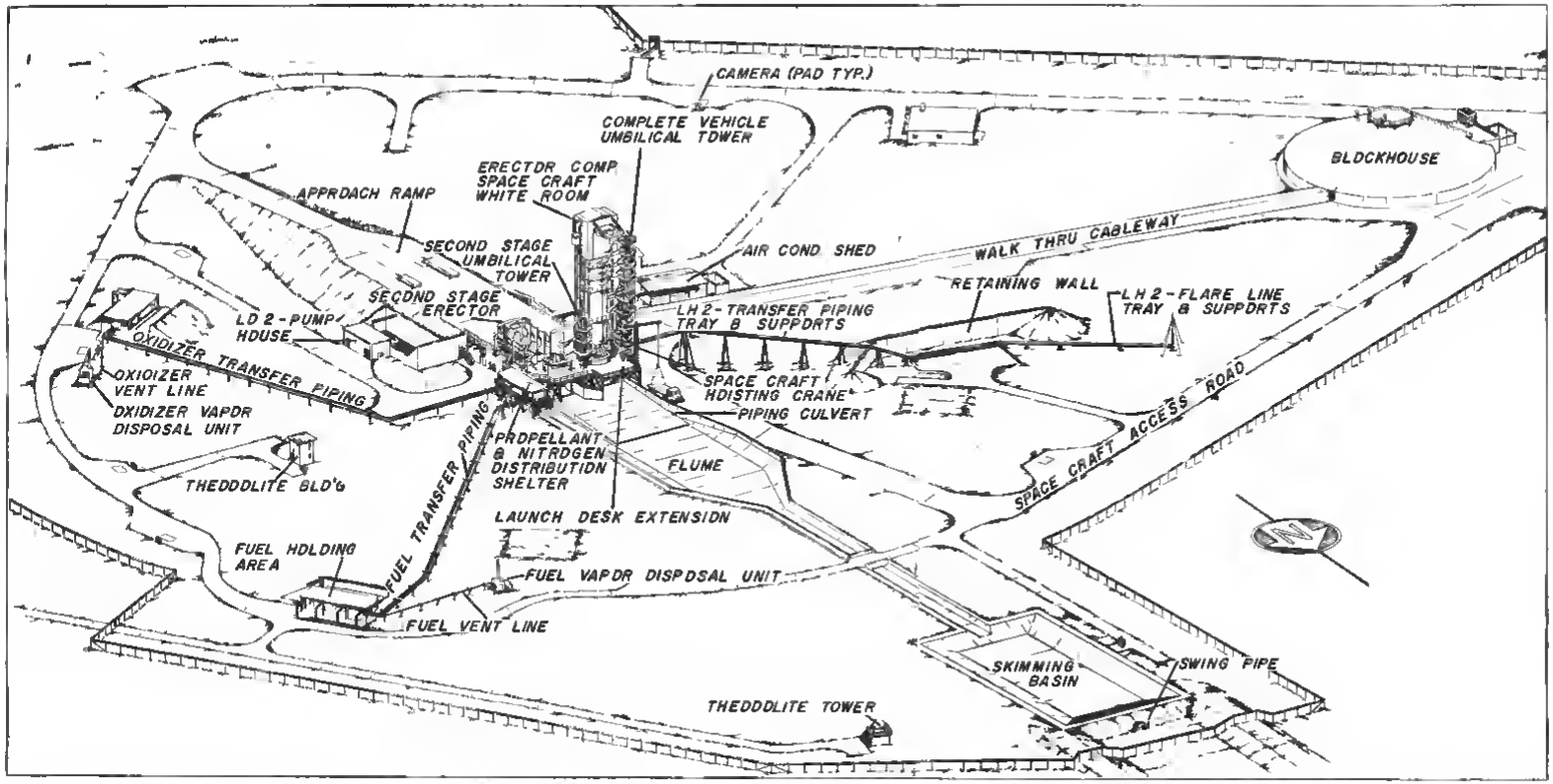
B E A Argosy operations by night. Note that the Argosy is designed with its floor at truck-bed height to make for easy handling of 'palletised' cargoes.

ARGOSY OPERATORS-LIKE BEA

With the rate of growth of passenger traffic slackening off, *freight* offers the big opportunities. The rewards will go only to those whose courage and foresight prompt them to invest in the right aircraft *now*. The Argosy — unlike converted passenger aircraft — is built for the job. That's why it can do it so much better. B E A, for example, are operating Argosies (often more than 12 hours a day on one aircraft) on *scheduled* services on European routes and achieving high load factors (e.g. 85% on the six-times-a-week round trips between U.K. and Germany). And B.E.A. are uncovering a whole *new* market in outsize freight, because the Argosy's full-width doors and unobstructed fuselage mean that all its cargo space is completely accessible. In addition, the new Argosy 200 series is in production, offering the same 30,000 hours guaranteed life, with bigger payload and better economics. Yes, freight operators who are going places must, repeat must, have Argosies!

HAWKER SIDDELEY AVIATION

32 Duke Street, St James's, London, S W 1



ARTIST'S DRAWING OF COMPLEX 19 at Cape Canaveral from which the Gemini Titan 2 will be flown, shows major elements.

NOTE TWO-POSITION launch stand. Both stages of Titan 2 can be fired sequentially

Simplicity, Duplication Will Give Titan 2 Manned Flight Capability

By George Alexander

Baltimore, Md – Simplicity of design, redundant malfunction detection system and painstaking manufacturing procedures are the major characteristics of the Martin Co.'s conversion of the Air Force Titan 2 ballistic missile to a man-rated launch vehicle for the National Aeronautics and Space Administration's Gemini two-man spacecraft.

Encouraged by the success of the first four flight tests of the Titan 2 weapon system from Cape Canaveral, Fla., Martin is confident that it will be able to deliver a proven booster to NASA late next year, when the first Gemini flight is tentatively scheduled. The company also expects to meet the extremely high reliability figure of approximately 99% demanded of the booster by NASA.

NASA's Manned Spacecraft Center, Houston, Tex., is buying 15 Titan 2 boosters from USAF, which acts as launch vehicle prime contractor for the Gemini program. Martin, in turn, is under contract to Air Force's Space Systems Division to build the vehicles. Total contract is estimated to be worth $120 million.

The booster, called a modified Titan 2 by USAF and a Gemini Launch Vehicle (GLV) by NASA, basically is a two-stage Titan 2 missile with only these minor airframe changes:

• **New forward skirt** above the second-stage oxidizer tank to accommodate the Gemini spacecraft instead of a General Electric Mark 6 warhead.

• **Re-designed truss section** between the oxidizer and fuel tanks of the second stage to carry the extra weight of a second guidance system and additional equipment, telemetry, instrumentation, etc.

• **Omission of retrorockets** and vernier engines from the second stage. Separation of booster and spacecraft will be effected by posigrade motors mounted on the capsule instead of retros on the launch vehicle. Second stage engine is considered adequate to meet velocity requirements of orbital injection without final trimming by verniers.

Key element in Titan's transformation from weapon system to space booster is the malfunction detection system (MDS), which is similar to the abort sensing and implementation system (ASIS) of the Mercury-Atlas launch vehicle. Primary goal of the malfunction detection system is crew safety and survivability, although it provides—as a secondary advantage—an increase in the probability of mission success.

MDS is designed to be operated manually by one of the two Gemini pilots. ASIS, in contrast, functions automatically with a manual override. NASA's decision to use a man-controlled, rather than an automatic, abort system for Gemini is based on two major considerations:

• **Sudden and catastrophic failure** of the Titan 2, using storable hypergolic propellants is far less likely than with a booster using cryogenic liquid oxygen. With one exception—engine flight controls—a malfunction in the Titan 2 will develop over a time period sufficiently long enough to permit the MDS to notice it, display it to the crew in the capsule and then allow the crew to react to the warning, initiate escape procedures and escape.

• **Problem-solving capability** of the human mind is superior to an automatic sequencer. An extensive effort was made in the Mercury program to develop the sequencing subsystems of ASIS and confirmed the belief that fewer parts mean fewer headaches. In simplifying the Gemini abort system and transferring the primary control mode to a human, NASA is not critical of the performance of ASIS to date, but simply prefers less complexity in a second generation system.

The malfunction detection system consists of a series of redundant sensors to monitor combustion chamber pressures in first and second stage engines, tank pressures in both stages, turning rates along pitch, roll and yaw axes, separation of first and second stage, and bus voltages. The sensors either are bi-level (green or red, go or no-go) or analog (a metered reading of some type) transducers. Bi-level sensors are connected in series and analogs in independent and parallel circuits.

To eliminate the possibility of component failure or spurious signals, contacts of both primary and redundant sensors monitoring a specific booster area must close simultaneously before a warning signal is transmitted to the appropriate display in a Gemini capsule.

All potential problems in the Aerojet General XLR87-AJ-5 first stage engines and XLR91-AJ-5 second stage engine have been reduced for the sensors to a pressure drop in the combustion chambers. Two pressure transducers, installed by Aerojet in each engine's injector plate at the time of manufacture, are connected in series and set to trigger a red warning light in the spacecraft when chamber pressure drops to 68% of that achieved at full thrust.

The two first-stage engines each develop 215,000 lb. thrust, and the single-barrel second stage engine generates 100,000 lb. thrust at altitude.

Booster Failure

In the event of booster failure between lift-off and an altitude of 50,000 to 75,000 ft., NASA presently is inclined to have the pilots escape from the spacecraft and launch vehicle by using their ejection seats (AW July 2, p. 94). Above this altitude, NASA is considering the use of the four Thiokol-built solid-propellant retrorockets within the capsule's adapter section to abort the flight and accelerate the manned craft away from the second stage of Titan 2.

Retrorockets would be ignited after thrust had been terminated in the stage then burning. This would prevent the launch vehicle following the spacecraft and possibly colliding with it.

Pressure levels within the fuel and oxidizer tanks of both stages are monitored by two (one primary, one redundant) analog transducers mounted in the top dome of each of the four tanks. Pressure drops affecting either the structural integrity of the airframe or suction pressure at the tank outlets to the engine pumps are of critical importance.

Each of the two fuel and two oxidizer tanks is represented by a meter

on the spacecraft's instrument panel. Each meter has two pointers corresponding to the two analog sensors on each tank. Should either the meter, the sensor or the link between the two fail, the corresponding pointer would go full scale on the meter and the pilot would know that his instrumentation—and not his booster—was at fault. On analog displays, the pilot will resolve contradictions in favor of the positive reading.

Tank pressures normally drop as the engines burn more and more fuel and the pressurizing gas is forced to fill more and more ullage.

Pressures may vary by 35 psia in first-stage tankage and by 50 psia in the second stage over the duration of powered flight without becoming critical. Should tank pressure drop abnormally, however, because of a clogged gas orifice or similar component failure, the pilots either can initiate abort/escape procedures or continue with the flight—depending on the severity of the drop and the time of its occurrence in the flight profile.

Large pressure drops at the beginning of the flight almost invariably would provoke an abort/escape situation, toward the end of a stage's burning, the crew might be able to coax the vehicle to the next step in the flight program.

Bi-level sensors report the thrust decay of the first stage as it approaches burn-out and thrust build up of the second stage (after ignition) by a red and green light, respectively. Second stage ignition, which precedes separation of the stages, is activated automatically by thrust decay or fuel depletion in the first stage or by a timer, whichever happens first. The timer normally is the initiator and also locks out premature second stage start up for a long part of first stage burning. Thrust decay, fuel depletion or loss of tank pressure in the first stage during this period, when the second stage is prevented from starting, would cause an abort/escape situation and be dealt with accordingly.

Exhaust of the XLR91-AJ-5 second-stage engine is vented through open blast ports in the inter-tank structure. When the engine is up to full thrust—a matter of milliseconds—four explosive bolts connecting the stages are fired and the second stage is released. MDS sensors indicate first-stage thrust decay, second-stage ignition and thrust build up and separation of the stages. Failure to get the correct panel light in any of these three areas could cause an abort situation.

Pitch, roll and yaw rates will be monitored by bi-level sensors to indicate when the vehicle is approaching its structural limits. All over-rates will be displayed by a single light on the crew's instrument panel, since the purpose of these sensors—like all other MDS elements—is not to fault-find but to warn.

Pitch and yaw rates exceeding 4 deg/sec during first stage and 10 deg/sec during second stage burning would cause an automatic switch-over device to transfer control from the primary to the back up guidance system and notify the crew of the change. Roll rates above 12 deg/sec also would bring in the back-up (inertial) system. If the over-rates continued with the inertial system, the crew likely would escape or abort. If the high rates ceased, the flight probably would be continued.

Voltmeter in the spacecraft will watch for a constant 28 v d c output from the auxiliary power system (APS) and its back up instrumentation power system (IPS). Auxiliary system—actually a misnomer, since it is the primary power source of the complete vehicle—consists of a 25 lb., rechargeable, silver-zinc battery with a 20 amp hr capacity. The IPS battery is the same type as the primary unit, but smaller, with a 12 amp-hr lifetime. Static inverter, which converts the d c output of the batteries into a c, has a capacity of 750 w and delivers 115/200 v at 400 cps.

Malfunction Detection

The malfunction detection system runs directly off the APS d c circuit, with the exception of the rate gyros, which run off the inverter. In the event of APS failure, the MDS would switch over to the IPS line. Normally, all flight functional equipment runs off the APS and all instrumentation, telemetry, etc., off the IPS.

Of all possible booster malfunctions, the one considered to be most dangerous and too sudden for effective crew reaction is engine hard-over in the first stage. Hard-over, or loss of control in the actuators that gimbal the engine, has occurred only once in Martin's experience—during a flight test of a Titan 1 weapon system. When the actuator system of one of the first-stage engines of this Titan failed, the powerplant swung sharply to its 5 deg. stop limit and held there, resulting in the missile's destruction.

The danger of this malfunction arises from the fact that the launch vehicle is still within the atmosphere during first stage operation and the dynamic forces (maximum Q) resulting from violent maneuvering would certainly destroy the vehicle. The problem is not nearly so severe with the second-stage engine, which operates in the extreme upper atmosphere where Q-forces would not be so great.

Tumbling probably would occur if the second-stage engine experienced hard-over during burning, but it is felt that the crew could effect an abort without too much difficulty.

To prevent hard-over in the first stage of Titan 2, Martin is installing a second complete hydraulic subsystem on each engine actuator. The redundant hydraulic units are connected in tandem on the same push-rod actuator, and each is supplied from independent reservoirs. Malfunction sensors are mounted on each primary hydraulic subsystem to detect low pressures or leakages. Should this happen, a switch would then put the redundant unit in operation.

First stage components of the malfunction detection system weigh 30.5 lb., including cabling, and second-stage components weigh 99.3 lb., including cabling. Most of the electronic hardware involved in the MDS is contained within the inter-tank area of the second stage.

Guidance systems of the Gemini Titan 2 are hybrids of Titan 1, Titan 2 and Mercury-Atlas elements. The General Electric-Burroughs Corp. radio command system of Mercury-Atlas plus the three-axis reference system (TARS) developed by Minneapolis-Honeywell for the Titan 2 weapon system, will be the primary system of the Gemini launch vehicle. It will replace the A C Spark Plug all-inertial guidance system of the Titan 2 weapon system.

Primary system contains the GE-Burroughs elements, the TARS package, Titan 2 autopilot, Titan 2 first-stage rate gyro package and the primary hydraulic subsystems of both first and second stage engines. The secondary system includes the A C Spark Plug all-inertial unit relocated within the spacecraft, separate Titan 2 autopilot and first-stage rate gyro package, and the redundant hydraulic subsystems of both first and second stage engines.

Radio Command Unit

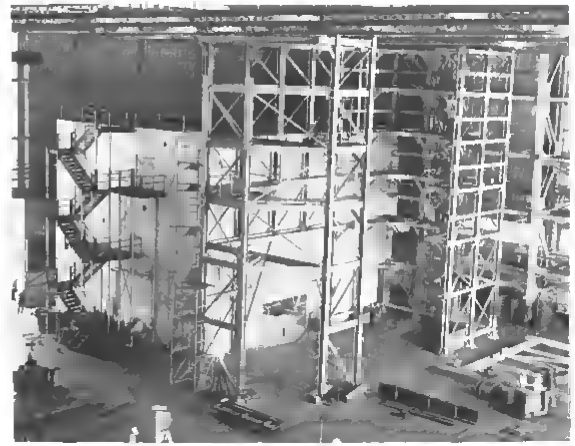
Replacement of the weapon system's all-inertial guidance by the radio-command unit was based on:

- **Weight and cost.** The radio-command system is approximately 200 lb. lighter and several hundred thousand dollars cheaper than the all-inertial system.
- **Variable launch azimuth capability.** The radio-command system can allow the launch vehicle to be rolled over a wider launch azimuth arc than the inertial unit.
- **Orbit determination capability.** The GE-Burroughs system provides tracking data up to the moment of orbital injection so that the Gemini control center can decide whether or not to continue the flight, the all-inertial system—flying closed loop—does not provide angular or velocity data to ground stations.
- **Experience.** Although both systems are considered to have the required accuracy for Gemini missions, much more flight experience has been obtained with radio command systems than inertial and the confidence level in the former consequently is higher.

Measurement of drift difference between two gyros, one located on the first stage and the other on the second stage, indicates dynamic forces exerted on the vehicle during first stage operation. This difference is translated into a signal which is fed into the autopilot and mixed there with other signals for steering commands to the Titan 2.

Dynamic loads of the Gemini Titan 2s are not expected to vary much from those experienced by weapon system Titan 2s. Weights of the Gemini spacecraft and the Mark 6 re-entry vehicle are within several hundred pounds of each other and their centers of gravity differ by less than 24 in. Gemini is expected to weigh 6,600 lb. for short-duration flights and 7,700 lb. for 14-day flights (AW July 2, p. 94).

Data gathered on the performance of the Titan 2 launch vehicle during flight will be telemetered back to ground stations by a primary and a back up system.



VERTICAL TEST FACILITY being built by the Martin Co. at Middle River, Md., will have two 155-ft.-tall cells in which to test and checkout Titan 2 launch vehicles destined to boost Gemini spacecraft. All systems—electronic, hydraulic, guidance and telemetry—will be tested in the facility except fueling and engine ignition. Three-story building behind the cells houses test systems and a functional test room for airborne elements of the Titan 2, such as the malfunction detection system.

Primary System

The primary system is PCM/FM (pulse code modulated, frequency-modulated), capable of handling nearly 200 analog and 50 bi-level measurements at rates of 20, 40, 100, 200 and 400 samples per sec. The back up system is FM/FM used in conjunction with an airborne tape recorder. The tape records data which cannot be transmitted over the PCM/FM system when the second stage engine is fired.

At time of ignition, exhaust of the second-stage engine is partially deflected off the top of the first stage and envelops both second stage and spacecraft. For less than 0.5 sec. telemetry frequencies are blacked out by the gas sheath. The tape recorder stores this data for later transmission. Tracking and rate radar frequencies are not affected by the back-flowing plume.

One of the primary objectives in the Gemini program is the rendezvous in space of a manned capsule and a propulsion stage, the Lockheed-built Agena. So that the spacecraft can meet the widest possible number of Agena's orbital planes that pass through or close to Cape Canaveral, Fla., Titan 2 will be capable of being launched along any bearing within a 35 deg. azimuth arc.

A direct hard line will link the computer center at NASA's Goddard Space Flight Center, Greenbelt, Md., with the Burroughs ground-based guidance radar at Cape Canaveral. Goddard will be constantly computing the orbital plot of Agena and passing this data directly to the Burroughs computer at the guidance building alongside the launch site, Complex 19.

Data then will pass from the guidance computer to a piece of Martin-built ground equipment within the blockhouse. This equipment, basically a semi-automatic sequencer and switcher, then transmits the Agena orbital data through another hard line to a timer-like device on the TARS package aboard the Titan 2.

This device called an intervalometer controls the beginning of the roll program after Gemini-Titan 2 has lifted off the pad. Based on the data received from Goddard, the amount of roll required by the Titan 2 to place the spacecraft along a trajectory coplanar with that of the Agena is translated into a time duration for the intervalometer. The earliest the roll can be initiated is 5 sec. after lift-off; latest is 20 sec. after lift-off when the launch vehicle must begin its pitch-over maneuver to start moving downrange.

Roll Capability

Titan 2 has a 20-deg. roll capability in either a clockwise or counterclockwise direction. If the booster must be rolled the full 20 deg. to be coplanar with the Agena, the roll must be started at liftoff plus 5 sec. The less roll required, the later it may be begun.

Although Titan's roll capability is 40 deg., limitations of Atlantic Missile Range instrumentation restrict its effective azimuth arc to 35 deg. It presently is estimated that there will be two 20-min. launch windows when the Agena's orbital progression brings the Lockheed stage within range of Cape Canaveral for periods of approximately two hours.

Gemini-Titan 2 will be launched from Complex 19 at Cape Canaveral. The stand, formerly used for Titan 1 launches, presently is being modified by the addition of a static test firing facility for the second stage. This is a two-hole stand; the first hole used for static test of the first stage and then launch of the complete vehicle, and the second hole for the static test of the second stage.

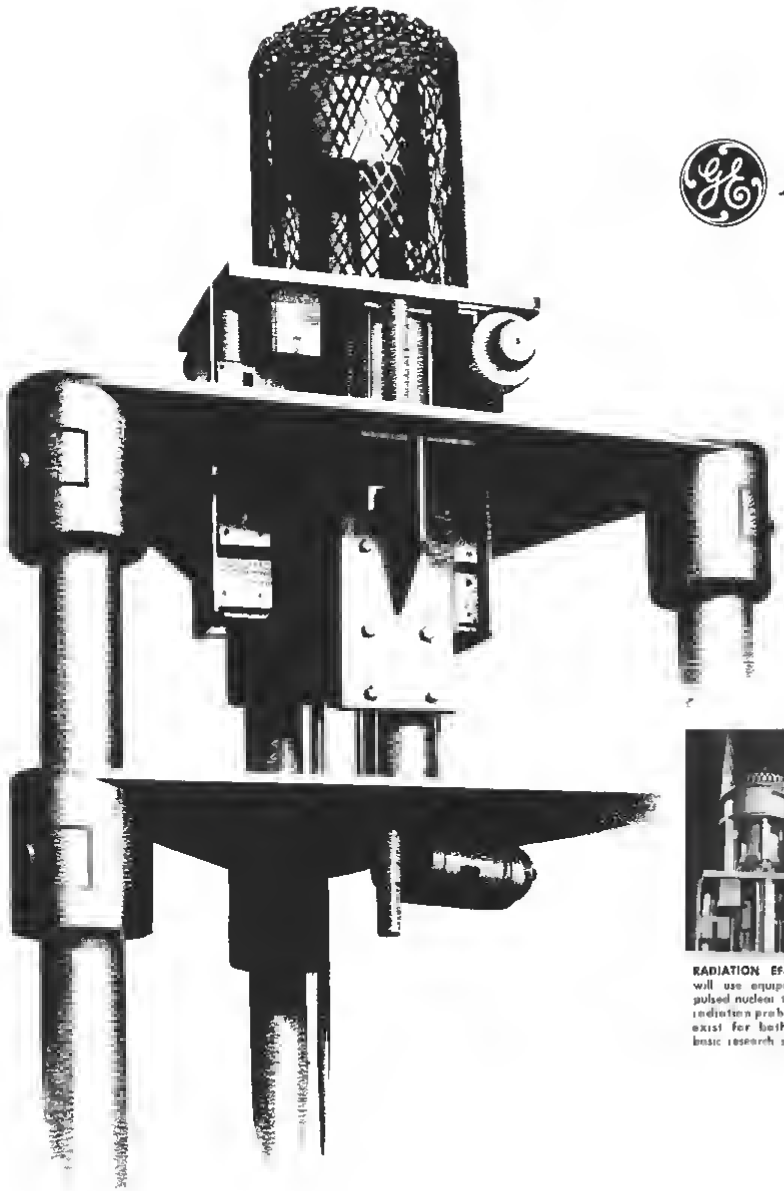
Sequence Firing

Prior to a flight, the stages of the booster will be separated and placed in their respective positions for a sequenced compatibility firing. As the name implies, the first stage will be fired first and then, within milliseconds, the second stage will be ignited. This exercise will simulate an operational flight, with all systems tested.

Following this sequence firing, the second stage will be mounted atop the first. The first stage will be static-fired again in a flight readiness test. If these three static firings do not reveal problems, the spacecraft will be installed on the Titan 2 booster in anticipation of an operational flight.

After delivery of a stage to Cape Canaveral but before the sequence firing, Martin will static fire each first and second stage twice for verification of each unit as an entity. The sequence and flight readiness firings are total-system tests.

Because McDonnell Aircraft Corp.,

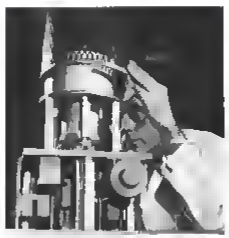


NEWS. . . . OF DEFENSE TECHNOLOGIES

NUCLEONICS

The damaging effects of radiation from nuclear weapons and space have introduced a whole new class of problems in the design of electronic systems and support equipment. For example, gamma radiation ionizes air to provide leakage paths for stray currents. Conventional insulating materials become partial conductors. The performance of transistors and ferrites is altered and voltages are induced in coils, wires, and cables. Van Allen radiation darkens the windows of space vehicles and causes deterioration of semi-conductor materials, such as solar cells.

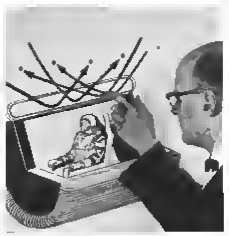
The creation of systems and equipment to function reliably in these environments requires special test facilities, skills, tools, and knowledge that have been developing at General Electric for more than twenty years. A newly organized Radiation Effects Operation is now integrating nuclear and electronic disciplines (nucleonics) and further developing the capabilities of the Company in this new field.



RADIATION EFFECTS OPERATION will use equipment such as this pulsed nuclear test reactor to solve radiation problems. Capabilities exist for both simulation and basic research in radiation effects.

HARDENED ELECTRONICS, such as this Thermionic Integrated Micro Module board, are being developed. TIMM circuits operate above 500°C and can tolerate 1000 times more radiation than conventional circuits.

NUCLEAR DETECTION SYSTEM (NUDETS-477L) is the first defense system combining nuclear and electronic technologies. It is being developed for U. S. Air Force to locate and measure any nuclear explosion in U. S.



SHIELDING OF SPACE VEHICLES from radiation may be possible by surrounding them with magnetic energy. This new concept, under study for NASA, may alleviate the need for heavier solid shielding.

ELECTRO-HYDRAULIC HANDYMAN is an example of remotely operated servo systems being produced to manipulate radioactive materials for routine tasks as well as highly specialized nuclear research projects.

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GENERAL ELECTRIC

DEFENSE ELECTRONICS DIVISION

builder of the Gemini spacecraft would like to test the attitude control system of the capsule after it has been mated to the booster, Martin is installing scuppers on the Complex 19 gantry at approximately the 100-ft level to vent the gases away from both the work stand and booster.

Manufacture of the Titan 2 for the Gemini program is a company-wide effort, Martin engineers emphasize.

The Denver Division is fabricating the domes and barrels that make up the booster's tankage, as well as the intertructures and skirts.

Denver will ship these components to Space Systems Division, Baltimore, where they will be assembled at the company's Middle River plant—a few miles from Baltimore.

Construction Plans

To build 15 Titan 2 boosters for the Gemini program, Martin intends to fabricate details—i.e., dome gores, barrel hoops, skirt segments, etc—in lots of eight and seven at a time in Denver.

These details will be welded together to form domes, cylinders, skirts, etc—called subassemblies—in three groups of four each and one group of three again in Denver.

After shipment to Baltimore, these subassemblies then will be brought together individually to build a complete Titan 2 booster.

Martin intends to be severe in accepting components and parts from vendors. Firms supplying Martin with parts have been instructed to eliminate any unit that reveals as much as a single blip during manufacture or testing.

Parts Critical

Parts considered to be critical will be accepted at the vendor's plant, under the supervision of a Martin employe. There will be no special separation of parts delivered to the Middle River facility—as is done at the General Dynamics Astronautics plant where Mercury-Atlases and Atlas weapon systems are made side by side—because only the Gemini Titan 2 will be made at the Middle River facility.

Any part delivered is a part intended to be installed only on a Gemini booster.

Also at Middle River, where the company now has about 700 engineers and 600 support personnel, a Vertical Test Facility (VTF) currently is under construction.

The facility will be capable of accommodating two boosters at a time. With the equipment contained within the three-story building behind the two test cells a complete systems countdown—identical to that which will be run at the Cape at the time of a flight except for engine ignition—can be conducted on the launch vehicle.

Oxygen Environment Reaction Tested

Tests to determine ability of an astronaut to function while breathing an atmosphere of up to 100% oxygen are being conducted under auspices of the National Aeronautics and Space Administration in the space simulator of Republic Aviation Corp., Farmingdale, N. Y. Subject, left, pumps exercycle in time to metronome. Lung capacity, pulse and respiration rate are recorded by sensors attached to his body. Two physicians observe reactions.

Carpenter Reports on MA-7 Observations

(Second U S manned orbital mission was flown by Navy Lt Cdr Scott Carpenter who successfully completed three orbits May 24 1962 AVIATION WEEK and SPACE TECHNOLOGY *s report on the Mercury MA-7 flight was carried* May 28, p 76, *and in succeeding editions The following is the pilot report prepared by Carpenter and delivered at a technical conference on results of the flight The conference was held* Aug 21 (AW Aug 27 p 30)

In this presentation, I shall attempt to give a narrative account of my impressions during the flight.

A period of more than two months, most of which was spent at Cape Canaveral, was consumed in preparing me for the orbital flight My activities during this period were very similar to those which I, as the backup pilot described in a paper on Astronaut Preparation for the MA-6 report The experience gained as the backup pilot to John Glenn was valuable practice for my own preparation period prior to the MA-7 flight In the discussion which follows, I will report my observations sensations, and experiences

Insertion into the spacecraft was accomplished without incident, except for a minor problem with the tiedown of the visor seal bottle hose to the helmet The countdown went perfectly until the 45-min weather hold At T-10 minutes it was picked up again and proceeded perfectly once more until liftoff. During the prelaunch period I had no problems. The couch was comfortable, and I had no pressure points. The length of the prelaunch period was not a problem I believe I could have gone at least twice as long Throughout this period, the launch vehicle was much more dormant than I had expected it to be. I did not hear the clatter that John Glenn had reported Once I felt the engines gimbaling. I do not recall hearing the Lox venting

When the ignition signal was given, everything became quiet I had expected to feel the launch vehicle shake, some machinery start, the vernier engines light off or to hear the Lox valve make some noise, but I did not Nothing happened until main engine ignition, then I began to feel the vibration There was a little bit of shaking Lift-off was unmistakable

About a minute and a half after liftoff, the sky changed in brightness rather suddenly It was not black, but it was no longer a light blue The noise and vibration increased so little during maximum dynamic pressure that it would not be noticed unless you were looking for it The booster engine cutoff (BECO) was very gentle Three seconds later, staging occurred There was no mistaking staging Two very definite noise cues could be heard one was the decrease in noise level that accompanied the drop in acceleration the other was associated with staging. At staging there was a change in the light outside the window and I saw a wisp of smoke

At tower jettison I felt a bigger jolt than at staging, and it was gone in a second Out the window the tower could be seen way off in the distance heading straight for the horizon It was rotating slowly, with smoke still trailing out of the three nozzles Just prior to BECO, I noticed a low-frequency oscillation in yaw This picked up again after BECO and increased very gradually until sustainer engine cutoff (SECO)

At SECO the dropoff in acceleration was not disturbing Two separate bangs could be heard first the clamp ring explosive bolts, and then, the louder noise of the posigrade rockets Best cues to the end of powered flight were weightlessness and absolute silence

I began the turnaround and wondered why I felt nothing At this time, the angular accelerations of the spacecraft were not perceptible, and only the blackness of space could be seen through the window The instruments provided the only reference The turnaround proceeded just as in the trainer except that I was somewhat distracted initially by the new sensation of weightlessness I followed the needles around and soon there was the horizon

Following the turnaround, I watched the expended launch vehicle through the window as it fell behind me, tumbling slowly It was bright and easily visible I could see what looked like

ASTRONAUT SCOTT CARPENTER prepares for simulated flight in Cape Canaveral's Hangar S prior to his MA-7 mission Assisting him is Gunter Wendt, spacecraft pad leader for McDonnell Aircraft Corp., Mercury prime contractor

(An artist's conception of a disaster that, fortunately, never has occurred)

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little ice crystals emanating from the sustainer engine nozzle. They seemed to extend for two or three times the length of the launch vehicle, in a gradually broadening fan pattern.

After the initial sensation of weightlessness, it was exactly what I had expected from my brief experience with it in training. It was very pleasant, a great freedom, and I adapted to it quickly. Movement in the pressure suit was easier and the couch was more comfortable. Later, when I tried to eat the solid food provided for the flight, I found it crumbled in its plastic bag. Every time I opened the bag, some crumbs would come floating out, but once a bite sized piece of food was in my mouth, there was no problem. It was just like eating here on earth.

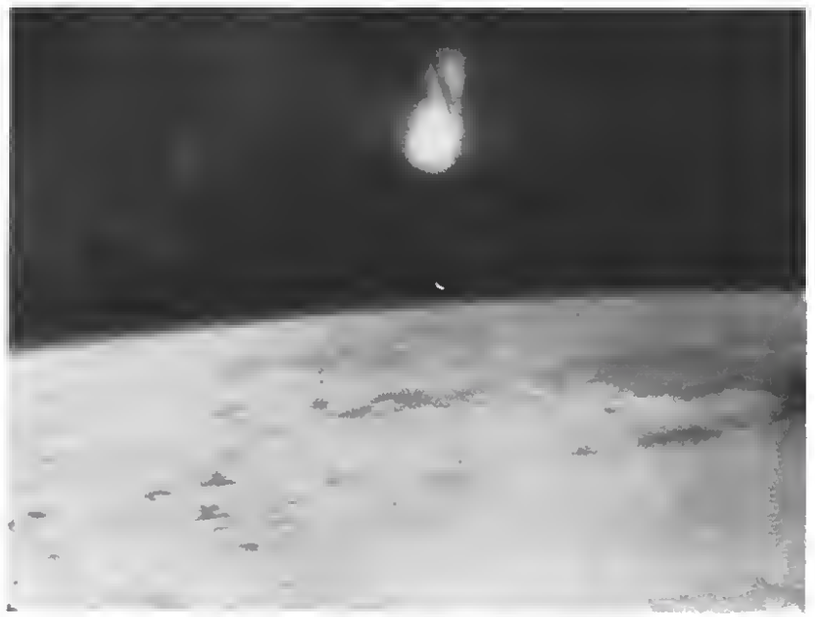
Motion Cues

My only cues to motion were the instruments and the view through the window and periscope. At times during the flight, the spacecraft angular rates were greater than 6 deg. per second, but aside from vision, it had no sense of movement.

I was never disoriented. I always knew where the controls and other objects within the cabin were relative to myself. I could reach anything I needed. I did have one unusual experience. After looking out the window for some time, I noticed that when I turned my head to the right to look at the special equipment storage kit, I would get the impression that it was oriented vertically, or 90 deg. from where I felt it should be. This impression was because of my training in the procedures trainer and lasted only temporarily.

At times when the gyros were caged and nothing was visible out the window, I had no idea where the earth was in relation to the spacecraft. However, it did not seem important to me. I knew at all times that I had only to wait and the earth would again appear in the window. The periscope was particularly useful in this respect, because it had such a wide field of view. Even without it, however, the window would have been adequate.

During the flight I had an opportunity to investigate a number of unusual flight attitudes. One of these was forward inverted flight. When I was pitched down close to minus 90 deg., I think I could pick out the nadir point, that is, the ground directly below me, very easily without reference to the horizon. I could determine whether I was looking straight down or off at an angle. During portions of the second and third orbits, I allowed the spacecraft to drift. Drifting flight was effortless and created no problems. Aligning the gyros consumed fuel or time. The horizon provided a good roll and pitch reference as long as it was visible in the window. On the dark side of the earth, the horizon or the airglow layer is visible at all times, even before moonrise. Yaw reference was a problem. The best yaw reference was obtained by pitching down minus 50 deg. to minus 70 deg. and looking through the window. The periscope provided another good yaw reference at nearly any attitude. The zero-pitch mark on the periscope was also a valuable reference for aligning the gyros since at zero-pitch, the horizon could not be seen through the window. Yaw attitude is difficult to determine at night, and the periscope is of little help in determining yaw on the night side. The best reference is a known star.



BOOSTER ROCKET which lofted Carpenter into orbit was photographed by the astronaut as it fell away after separation from the spacecraft.

Manual Control

For normal maneuvering in orbit, fly-by-wire, low thrusters was the best system. However, I believe for a tracking task, manual proportional control might be more desirable, although I did not actually try it for this purpose. The fly-by-wire high thrusters and the rate command auxiliary damping systems were not needed for the tasks that I had to perform in orbit prior to preparing for retrofire.

In orbit, the operation of the solenoids of both the high and low thrusters of the fly-by-wire system could be heard. I could hear and feel the rate command system, both the solenoids and the thruster. When using the manual proportional mode, I did not hear the control linkages, but again I heard the thrusters. Through the window, the exhaust from the pitch-down thrusters could be seen. There was no movement, just a little "V" of white steam in front of the window. It was visible even at night.

At balloon deployment, I saw the confetti as it was jettisoned, but it disappeared rapidly. I saw one of the balsa blocks and mistook it for the balloon. Finally, the balloon came into view, it looked to me like it was a wrinkled sphere about 8 to 10 in. thick. It had small protrusions coming out each side. The balloon motion following deployment was completely random.

There was no difference between the appearance and color of land, water areas, or clouds from orbit and the view from a high-flying aircraft. The view looked to me exactly like the photographs from other Mercury flights. The South Atlantic was 90% covered with clouds, but all of western Africa was clear. I had a beautiful view of Lake Chad. Other parts of Africa were green, and it was easy to feel that these areas were jungle. There were clouds over the Indian Ocean. Farther west in the Pacific, it was not heavily clouded, but the western half of Baja California, Mexico, was covered with clouds along its entire length. The eastern half was clear. Over the United States on the second orbit, I noticed a good amount of cloudiness, but after retrofire I could see the area around El Centro, Calif., quite clearly. I saw a dirt road and had the impression that had there been a truck on it, I could have picked it out. I did not see Florida or the Cape Canaveral area.

Because of the small source of light

around the time circulation clock, I was not fully dark adapted, nor was the cabin completely dark, therefore, I did not see any more stars than I could have seen from the earth. After having seen the star, Corvus, during the flight and later in the recovery airplane, I am convinced that a lot more stars can be seen from the ground than I could see through the spacecraft window. I could, nevertheless, readily see and identify the major constellations and use them for heading information. I could not see stars on the daylight side of the earth was in the field of view of the window. However, I do remember seeing stars at the western horizon when the sun was just up in the east but the terminator had not yet reached the western horizon. The sunrises and sunsets were the most beautiful and spectacular events of the flight. Unlike those on earth, the sunrises and sunsets in orbit were all the same. The sharply defined bands or color at the horizon were brilliant.

Light Band

On the dark side of the earth, I saw the same bright band of light just above the horizon which John Glenn reported. I measured the width of this band in a number of ways and I also observed it through a special "airglow" filter.

A number of times during the flight I observed the particles reported by John Glenn. They appeared to be like snowflakes. I believe that they reflected sunlight and were not truly luminous. The particles traveled at different speeds, but they did not move away from the vehicle as rapidly as the confetti that was deployed upon balloon release. At dawn on the third orbit as I reached for the densiometer I inadvertently hit the spacecraft hatch and a cloud of particles flew by the window. Since I was yawed to the right, the particles traveled across the front of the window from the right to the left. I continued to knock on the hatch and on other portions of the spacecraft walls, and each time a cloud or particles came past the window. The particles varied in size, brightness and color. Some were gray and others were white. The largest were 4 to 5 times the size of the smaller ones. One that I saw was a half inch long. It was shaped like a curlicue and looked like a lathe turning.

Particle Source

I think that one reason that I got behind at retrofire was because, just at dawn during the third orbit, I discovered the source of the space particles. I felt that I had time to get that taken care of and still prepare properly for retrofire, but time slipped away. The Hawaii Cap Com was trying very hard to get me to do the preretrograde checklist. After observing the particles I was busy trying to get aligned in orbit attitude. Then I had to evaluate the problem in the automatic control system.

I got behind and had to stow things haphazardly.

Pitch Attitude Problem

Just prior to retrofire, I had a problem in pitch attitude, and lost all confidence in the automatic control system. By this time, I had gone through the part of the preretro checklist which called for the manual fuel handle to be out is a backup for the automatic control system. When I selected the fly by wire mode, I did not shut off the manual system. As a result, attitude control during retrofire was accomplished on both the fly-by-wire and the manual control modes.

At the time, I felt that my control of spacecraft attitude during retrofire was good. My reference was divided between the periscope, the window, and the attitude indicators. When the retroattitude of minus 34 deg was properly indicated by the window and the periscope, the pitch attitude indicator read minus 10 deg. I tried to hold this attitude on the instruments throughout retrofire, but I cross-

NAVY HSS-2 helicopter hauls Carpenter from the water after completion of the MA-7 flight. Flotation device is wrapped around the capsule at lower left

checked attitude in the window and the periscope. I have commented many times that on the trainer you cannot divide your attention between one attitude reference system and another and still do a good job in retrofire. But that was the way I controlled attitude during retrofire on this flight.

Retrofire Late

Although retrosequence came on time, the initiation of retrofire was slightly late. After receiving a countdown to retrofire from the California Cap Com, I waited 2 sec. and then punched the manual retrofire button. About 1 sec. after that I felt the first retrorocket fire.

If the California Cap Com had not mentioned the retroattitude bypass switch, I would have forgotten it, and retrofire would have been delayed considerably longer. Later, he also mentioned an auxiliary damping re-entry which I think I would have chosen in any case, but it was a good suggestion to have.

I had expected a big "boot" from the retrorockets. But the deceleration was just a very gentle nudge. The ignition of the rockets was just audible. Retrofire gave me a sensation not of being pushed back toward Hawaii as John Glenn had reported, but of being slowed down in three increments. By the time the retrofire was over, I felt that there had been just enough deceleration to bring the spacecraft to a stop, but of course it had not stopped.

Retropack jettison and the retraction of the periscope occurred on time. At this time, I noticed my appalling fuel state and realized that I had controlled retrofire on both the manual and fly-by-wire systems. I tried both the manual and the rate-command control modes and got no response. The fuel gage was reading about 6%, but the fuel tank was empty. This left me with 15% on the automatic system to last out the 10 min. to 0.05g and to control the re-entry. I used it sparingly, trying to keep the horizon in the window so that I would have a correct attitude reference. I stayed on fly-by-wire until 0.05g. At 0.05g I think I still had a reading of about 15% on the automatic fuel gage. I used the window for attitude reference during re-entry because of the difficulty I had experienced with the attitude displays prior to the retrofire.

I began to hear the hissing outside the spacecraft that John Glenn had described. The spacecraft was aligned within 3 deg. or 4 deg. in pitch and yaw at the start of the re-entry period. I feel that it would have re-entered properly without any attitude control. The gradual increase of aerodynamic forces during the re-entry appeared to be sufficient to align the spacecraft properly. Very shortly after 0.05g, I began to pick up oscillations on the pitch and yaw rate needles. These oscillations seemed about the same as those experienced in some of the trainer runs. From this I decided that the spacecraft was in a good re-entry attitude, and I selected the auxiliary damping control mode.

Re-entry Observations

I watched both the rate indicator and the window during this period, because I was beginning to see the re-entry glow. I could see a few flaming pieces falling off the spacecraft. I also saw a long rectangular strap going off in the distance. The window did not light up to the extent that John Glenn reported. I did not see a fiery glow prior to peak acceleration.

I noticed one unexpected thing during the heat pulse. I was looking for the orange glow and noticed instead a light green glow that seemed to be coming from the cylindrical section of the spacecraft. It made me feel that the trim angle was not right and that some of the surface of the recovery compartment might be overheating. However, the fact that the rates were oscillating evenly strengthened my conviction that the spacecraft was at a good trim angle. The green glow was brighter than the orange glow around the window.

I heard the Cape Cap Com up to the blackout. He told me that blackout was expected momentarily. I listened at first for his command transmission, but it did not get through.

So I just talked the rest of the way down.

At peak acceleration, oscillations in rate were nearly imperceptible, since the auxiliary damping was doing very well. The period of peak acceleration was much longer than I had expected. I noticed that I had to breathe a little more forcefully in order to say normal sentences.

At around 70,000 ft., I may have run out of automatic fuel. I do not remember looking at the fuel gage, but the rates began to oscillate pretty badly, although the rate needles were still on scale. My best indication of the oscillation amplitude was to watch the sun cross the window and try to determine the angle through which the spacecraft was oscillating. I could feel the change in deceleration as the spacecraft went to one side in yaw or pitch.

I switched the drogue parachute fuse switch on at about 45,000 ft. At about 40,000 ft. spacecraft oscillations were increasing. At about 25,000 ft., I deployed the drogue parachute manually when the oscillations became severe. I could see the drogue parachute pulsing and vibrating more than I had expected. It was visible against a cloudy sky. After the drogue parachute was deployed, I operated the snorkel manually.

Main Chute Deployed

I switched the main parachute fuse switch on at 15,000 ft. and waited for the main parachute to deploy. At about 9,500 ft. I manually activated the main parachute deployment switch without waiting for automatic deployment. It came out and was reefed for a little while. I could see the parachute working as the material was stretched taut and then as it undulated after the peak load. The parachute disreefed and it was beautiful. I could see no damage whatsoever, and rate of descent was right on 30 fps.

I was convinced that the main parachute was good, selected the automatic position on the landing bag switch, and the bag went out immediately. I went through the post re-entry and 10,000 ft. checklists and got everything pretty well taken care of.

The landing was much less severe than I had expected. It was more noticeable by the noise than by the g load and I thought I had a re-contact problem of some kind. I was somewhat dismayed to see water splashed on the face of the tape recorder box immediately after impact. My fears that there might be a leak in the spacecraft appeared to be confirmed by the fact that the spacecraft did not immediately right itself.

The spacecraft listed halfway between pitch down and yaw left. I got the proper items disconnected and waited for the spacecraft to right itself. However, the list angle did not appreciably change.

I knew that I was way beyond my intended landing point, because I had heard earlier the Cape Cap Com transmitting blind that there would be about an hour for recovery. I decided to get out at that time and went about egressing from the spacecraft.

Egress is a tough job. The space is tight, and the small pressure bulkhead stuck slightly. I easily pushed out the canister, and I had the raft and the camera with me. I disconnected the hose after I had the canister nearly out.

I forgot to seal the suit and deploy the neck dam. I think one of the reasons was that it was so hot. After landing I read 105 deg. on the cabin temperature gage. I felt much hotter in orbit than after landing and although it was humid, I still felt fine.

Egress Accomplished

I climbed out through the small pressure bulkhead with the raft attached to me. I placed the camera up on top of the recovery compartment so that I could get it in case the spacecraft sank. I left the spacecraft, pulled the raft out after me, and inflated it still holding onto the spacecraft. I climbed aboard and assessed the situation. Then I realized that the raft was upside down! I climbed back onto the spacecraft, turned the raft over, and got back in.

The sea was quite calm except for periodic swells, but it was not choppy. The time on the ocean was very pleasant. I drank a lot of water from my survival kit while I was in the raft but as far as temperature was concerned I was comfortable.

The first thing I saw in the water was some seaweed. Then a black fish appeared and he was quite friendly. Later I heard some planes. The first one I saw was a P2V, so I took out the signaling mirror from my survival kit. Since it was hazy, I had some difficulty in aiming the mirror which is done by centering the small bright spot produced by the sun in the center of the mirror. However, I knew the planes had spotted me because they kept circling the area. Another aid to the planes in locating me was the dye marker which was automatically ejected by the spacecraft; there must have been a stream of dye in the water 10 mi. long.

Swimmer Appears

Soon there were a lot of airplanes around but I just sat there minding my own business. Suddenly I heard a voice calling from behind me. I turned around and there was someone swimming up to me. I did not even know that he had been parachuted into the water. He inflated his raft, climbed in, and attached his raft to mine. He told me he had parachuted from 1,100 ft. and had to swim quite a way to reach me. Later, another swimmer joined us. I broke out the food and asked them if they wanted any, but they had finished lunch recently, and they did not take any.

More aircraft kept circling over us. From time to time, one would drop a smoke bomb marker. A 20-man liferaft was dropped, but the chute failed to open and it hit the water with a tremendous impact. Attached to the raft was another package, containing the Stullken collar, a flotation device much like a life preserver which can be wrapped around the spacecraft to keep it floating. It also hit with a terrific force which, as we learned later, broke one of the CO_2 bottles used to inflate the collar. The divers started out to get the collar and it took them some time to bring it back. They finally got back, wrapped the collar around the spacecraft, and inflated it.

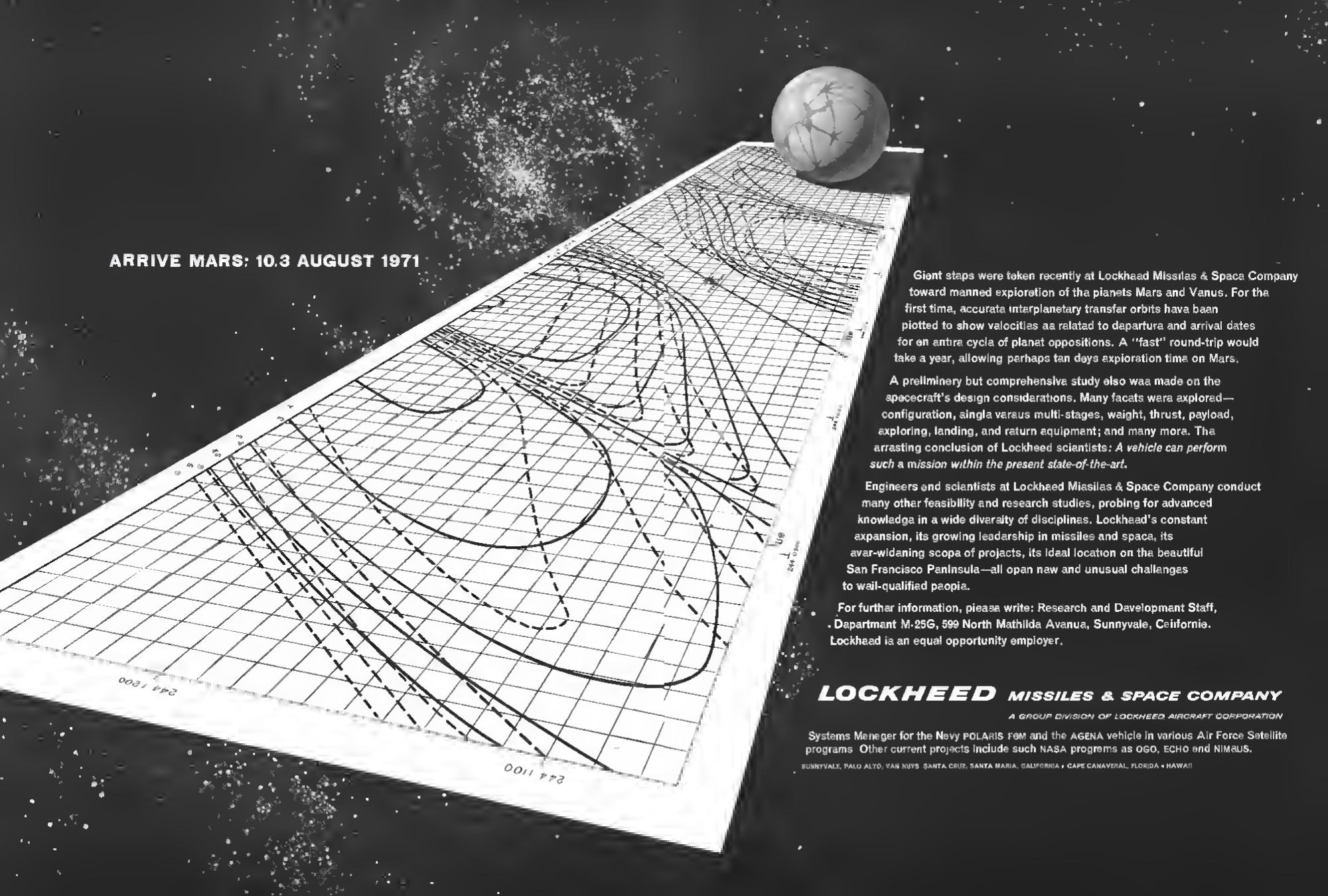
When the HSS-2 helicopter appeared, it made a beautiful approach. One of the divers helped me put on the sling, and I picked up my camera which I had previously placed in the recovery compartment. I motioned to the helicopter pilot to take up the slack in the line, and I let go of the spacecraft expecting to be lifted up. Instead, I went down! The helicopter must have settled slightly, because I am sure that there was a moment when nobody saw anything of me but a hand holding a camera clear of the water.

Helicopter Pickup

A moment later, however, I began to rise. It was a lift of some 50 to 60 ft. I got into the helicopter with no difficulty and took off my gloves and boots. I poked a hole in the toe of my left sock and stuck my leg out the window to let the water drain out of the suit. When the helicopter landed aboard the carrier, I was in good shape. Although I had already had a long day, I was not excessively tired and I was looking forward to describing my experiences to those at the debriefing site.

Over-all I believe the MA-7 flight can be considered another successful step on the road to the development of a useful and reliable manned spacecraft system. The good performance of most of the spacecraft systems gave me confidence in the vehicle itself, while the spectacular novelty of the view from space challenged me to make the most of my opportunity, and lured me into an unwise expenditure of fuel early in the flight. As a result, it became necessary to go to extended drifting flight. And I was able to demonstrate that there was no problem associated with prolonged drifting flight, a procedure we shall have to make use of on the longer duration Mercury flights. I was able to detect and overcome the one significant systems malfunction that might have affected the flight: the malfunction of the pitch horizon scanner circuit. I understand that many were concerned while waiting without word from me during re-entry and after landing. However, from my position, there was no major cause for concern. The spacecraft was stable during the critical portions of the re-entry and the parachute worked perfectly.

For me, this flight was a wonderful experience, and I anxiously await another space mission.



Giant steps were taken recently at Lockheed Missiles & Space Company toward manned exploration of the planets Mars and Venus. For the first time, accurate interplanetary transfer orbits have been plotted to show velocities as related to departure and arrival dates for an entire cycle of planet oppositions. A "fast" round-trip would take a year, allowing perhaps ten days exploration time on Mars.

A preliminary but comprehensive study also was made on the spacecraft's design considerations. Many facets were explored—configuration, single versus multi-stages, weight, thrust, payload, exploring, landing, and return equipment; and many more. The arresting conclusion of Lockheed scientists: *A vehicle can perform such a mission within the present state-of-the-art.*

Engineers and scientists at Lockheed Missiles & Space Company conduct many other feasibility and research studies, probing for advanced knowledge in a wide diversity of disciplines. Lockheed's constant expansion, its growing leadership in missiles and space, its ever-widening scope of projects, its ideal location on the beautiful San Francisco Peninsula—all open new and unusual challenges to well-qualified people.

For further information, please write: Research and Development Staff, Department M-25G, 599 North Mathilda Avenue, Sunnyvale, California. Lockheed is an equal opportunity employer.

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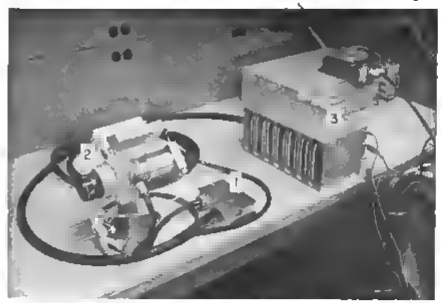
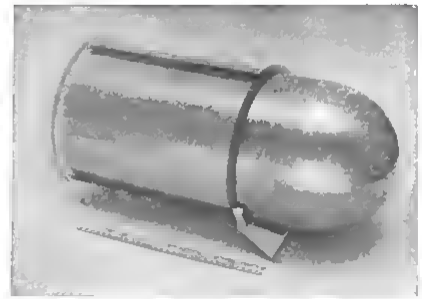




OPERATING BREADBOARD of vidicon TV camera system (left), which may go aboard a Mariner space probe for obtaining pictures of the planet Mars. At right is mockup of telescope housing and thermal shield for narrow-angle TV camera. Bullet-shaped end would contain the camera electronics. Opposite end is open except for sun and dust shield. Fabrication of flight version of the 400-line camera system, developed at Jet Propulsion Laboratory, will be given to industry when specific mission is assigned to system. Visible parts include power supply (1), RF coupling between vidicon target and preamp (2), spacecraft electronics (3).

Advanced Video Ideas to Have Space Use

By Barry Miller

Pasadena, Calif.—Two new camera systems that may enable deep space probes to take and return pictures of the planets Mars, Mercury and Jupiter are being developed as part of an overall effort in advanced video techniques for lunar and planetary exploration.

These advanced development projects are conducted in house and with industry by the Space Sciences Division of Jet Propulsion Laboratory. The Laboratory manages National Aeronautics and Space Administration's unmanned lunar and planetary interplanetary space programs.

The more unusual of the two cameras, and the more remote from realizeable flight hardware, is a radical departure from conventional camera techniques. Presently entering the breadboard stage, it is expected to evolve into a compact, all solid-state device using thin photoconductive, ferroelectric and electroluminescent films to realize triple functions of imaging, storage and readout.

While probably not capable of matching the resolution of a vidicon camera system, the solid state camera has a multitude of other potential advantages, according to Ray Heacock, who heads the Space Instrument Development Section of Space Systems Division. These advantages include high reliability, wide dynamic range, high speed and good sensitivity and possibility of running on the power now required by the filament of a vidicon alone.

Camera of this type being developed for JPL by Electro Radiation, Inc., Los Angeles, might prove suitable for Jupiter and Mercury flyby missions later this decade. The Planetary Program Office here has discussed such flights with industry in recent weeks.

The other camera, an in-house advanced effort well along in development, is a vidicon camera with associated encoder for converting video signals into digital form for tape storage before telemetering back to earth. It is a potential Mars mission system, informally called the Martian camera. It has taken excellent pictures, JPL says, and test patterns taken after encoding showed only minor degradation. JPL engineers say they believe the feasibility of this photographic system for planetary missions has been demonstrated successfully.

Neither camera is planned for a specific flight or even a mission, but both are designed within constraints of planetary space missions. In line with the Laboratory's general policy of seeking industry participation in fabricating flight hardware from advanced developments conducted in house, a contract to produce a packaged system will be placed with industry if and when a specific mission is assigned to the Martian camera. JPL is known to be giving top priority to obtaining TV pictures of Mars with its Mariner B or substitute Mariner M spacecraft (AW July 16, p. 32).

Both the Martian vidicon system and a complete solid-state camera system now being developed have similar over-all system parameters. Their optics were chosen for similar light inputs, their spectral responses both peak at about 5,500 angstroms, their readout times (about 15 sec.) are similar. The Martian camera is a 400 line system (compared with 200 lines for Ranger 3 through 5 cameras), the solid-state camera is to have a 400 x 400 mosaic, equivalent of a 400 line vidicon system.

Other devices for securing or storing video data being developed here or in industry for the Space Sciences Division include:

• **Tape Recorders**—Several types of tape recorders, potentially capable of storing digital image signals corresponding to tens or hundreds of TV pictures taken on planetary missions. One is an in-house advanced development effort on a digital tape transport, another is a 500 bits/in. packing density machine for recording six tracks of data in parallel. The latter is under development at Raymond Engineering Laboratory, Inc., Middletown, Conn., for possible use as a TV picture storage device on a Mariner B shot.

• **High Density Core or Film Storage**—As an alternative to storing video and other data on tape, JPL is looking at several schemes involving magnetic cores or magnetic films which may have storage capacities approaching billion bits to accommodate an anticipated rise in space data storage requirements. Recently, it let studies to International Business Machines, Radio Corp. of America and Univac Division of Sperry Rand for high-density storage devices, possibly leading to flight worthy items. These devices might compare favorably in size with tape machines, with the added virtues of being more reliable—in the absence of moving parts and the freedom from recording head contamination—as well eliminating bearings and their lubrication difficulties. Draw-

back of these devices at this stage—high cost—is estimated at roughly a penny a bit for core storage.

▪ **Ultra-High Speed Space Camera**—Breadboard model of an ultra high speed space camera using components made of fiber optics and photoconductive phosphors to give it combinations of features required for photographing and mapping planetary bodies from spacecraft is being developed by Optics Technology, Inc., under a $95,000 contract (AW Feb 12, p. 34). Elements of this system include a combination fiber optics and phosphor high-gain image intensifier. Among characteristics which this breadboard system might ultimately yield are low relative apertures (less than f/1), wide field angles (200 to 40 deg.), ability to approach image quality the diffraction properties of light, to function not only in the visible portion of the optical spectrum but in the infrared or ultraviolet as well, and to perform under space environmental conditions.

Basic concept of the operation of the solid-state camera, being developed by Electro Radiation and indicated in functional form on p. 65, involves sandwiching together a single crystal ferroelectric and photoconductive layer between thin, transparent, conductive glass materials or electrodes. The photoconductor acts as a light sensitive element, the ferroelectric as a storage medium, corresponding in effect to the roles of the vidicon camera tube phosphor and a tape recorder.

Unusual Properties

Ferroelectric crystals have numerous unusual properties which enable them among other things to store charge, much as would its electrical equivalent, a voltage variable capacitor. It has characteristics, particularly the ability to show spontaneous polarization and hysteresis effects, analogous to those of familiar ferromagnetic materials like nickel and iron.

A single crystal of barium titanate, for example, has a nearly square characteristic hysteresis loop, in this case a plot of electric displacement against electric field strength rather than magnetic flux density as a function of magnetic field strength as in ferromagnetic materials.

When an electric field of a given polarity is applied it brings about a change in polarization of the crystal which can be erased by the application of a field of opposite polarity.

Picture taking in the camera is accomplished by projecting an image on the surface of the photoconductive layer, whose resistance at the point at which light impinges drops as a direct function of light intensity. Simultaneously, with the imaging action a pulse is applied to the sandwich bringing about a change in polarization in the ferroelectric crystal corresponding to the light input. The amount of charge stored in the crystal at any point of the picture bears a linear relation to the intensity of light at that point. Then, the stored charge can be retained for controlled periods.

To read out the picture, a procedure similar to the one employed in the picture-taking process is used. A pinpoint of light selects a desired point for interrogation, other points remaining isolated by the high dark resistance of the photoconductor. Simultaneously, a voltage pulse of a polarity opposite that applied in the picture-taking step is generated, thereby extracting the charge stored at that point. This is integrated to give a voltage output proportional to the extracted charge. The point is thus automatically erased on readout, the ferroelectric returns to the initial point on the hysteresis loop and is ready for another picture-taking process.

Electro Radiation made a prototype memory using single crystal barium titanate and a specially doped cadmium sulfide photoconductor which peaks at about 5,800 angstroms in the visible portion of the spectrum. One interesting byproduct of this work is the possibility of achieving an infrared camera as in the Optics Technology project, by substituting an infrared responsive photoconductor for the cadmium sulfide photoconductor.

Some units were constructed during an initial $85,000 contract from JPL. All the units displayed good linearity of output signal to input illumination, according to Electro Radiation. Output voltage vs. illumination curve slopes, equivalent to the gamma of the system, were made from ½ to 2 depending on type and doping of the photoconductor. Devices tested showed a sensitivity below 0.1 foot candles of illumination and resolution of 100 lines per inch. Pictures could be taken by the units tested in 0.1 to 25 millisec., depending on illumination.

Ferroelectric shutter, also made and demonstrated during the initial JPL contract, consists of a second ferroelectric crystal between a pair of parallel polarizers. With the polarizers at one fixed relation to one another, the device is opaque. When a field supplied by a 20 to 100 volt pulse is applied, the shutter passes light.

Disadvantage of this system is that one sandwich combination is required for each picture or each sandwich must be divided with parallel outputs to the integrator network for separate pictures or picture points.

Other Developments

Company, now working under a $4 million follow-on contract from JPL is making a 400 x 400 matrix of individual picture points. It also is developing a solid-state readout in the form of an electroluminescent matrix which is to be juxtaposed to the ferroelectric. Particular type of electroluminescent phosphor being examined is radioluminescent as well. That is, when the phosphor is struck by a radioactive particle it will luminesce more efficiently than it will when excited by an alternating electric field alone as in conventional electroluminescence.

Electroluminescent radioluminescent phosphor, in a matrix matching that of the ferroelectric, can selectively interrogate each point in the ferroelectric. Each element in the electroluminescent matrix will be excited by an applied voltage and a radioactive source thereby providing a point source of light to lower the photoconductive resistance. When the ferroelectric is simultaneously pulsed by a voltage of polarity opposite that used during the picture taking step charge is extracted from that point and integrated. Each element will be scanned in this fashion until the entire picture content of the ferroelectric crystal is extracted, and the ferroelectric cleared and made ready for reuse.

Size of the sandwich currently is limited by the maximum size of a single crystal ferroelectric which eventually can be made as a film as are the photoconductors and electroluminescent elements.

During the current JPL contract, Electro Radiation will seek to develop a complete camera with shutter, memory matrix and solid-state readout and demonstrate a working camera by early next summer.

The device may be no larger than a one inch cube plus its electronics and optics. With the complete drive circuitry it might occupy the size and equal the weight of a vidicon. For flight conditions, it should be as capable of withstanding vibration, shock and other space environments as a vidicon. Its operating temperatures would be governed by the Curie temperatures (temperatures beyond which the material loses its ferroelectric properties) which range from minus 60C to 125C for barium titanate, to 450C for a material like cesium niobate.

JPL's Martian camera is an airborne shuttered, single-frame TV system with six bit digital encoder, logically controlled from a 1 mc synchronous clock. It probably will employ either an RCA or General Electrodynamics vidicon tube.

As a dual two-camera system in a space mission, one camera with telescopic lens would function as a narrow angle high-resolution system capable of obtaining mission pictures for Mars with a resolution as high as 1 km. The second would have optics for a wide angle system to take pictures of 5 km resolution. Outputs would be encoded, stored on tape with amplitude and time integrity preserved.

System Weight

This maximum capability system, two cameras optics, etc., would scale roughly 35 lb a single camera reduced performance system including encoder and lens would run about 9 lb.

In the encoder designed in house for this camera system, video signals are fed to differential amplifier at the instant a gate is opened with a sync signal from the programmer, permitting 1 mc pulses to pass through the gate to an accumulator. Simultaneously with the

Pictures of the Planets

Techniques for securing television pictures of the planet Mars are getting top priority attention from Jet Propulsion Laboratory because of the wealth of information they could provide about the physical makeup and geology of the planet's surface.

Highest optical resolution that can be expected by telescopic observations of the planet from the earth is on the order of 100 km. Pictures taken from a spacecraft providing even a single order of magnitude improvement or a resolution of about 10 km, would be a significant advance. JPL says it might achieve this and do as well as 1 km resolution depending on the mission, with a TV camera, presently in breadboard stage of development and intended for inclusion on the 1964 Mariner B Mars flyby attempts.

It now appears that these dual flyby attempts will be replaced by lighter weight payloads (AW July 16, p. 32) to make possible use of boosters like Atlas-Agena B, certain to be available then. A modified form of the Mariner B or Martian camera (see story) may be employed in the substitute vehicles.

As planetary exploration continues, and interest focuses on the more distant planets of Mercury and Jupiter during the anticipated Voyager project, pictures will continue to be invaluable scientific tools.

Where power available for transmission of image signals corresponding to scanned images on a TV camera tube and other data from deep space is limited, as it will be over the multi-million mile distances from spacecraft even in the vicinity of a neighboring planet like Mars, digital communications will be employed because of their more efficient use of communications bandwidth. Low transmission bit rates from the spacecraft make necessary on board storage of TV data a requirement not imposed on the Ranger and Surveyor lunar spacecraft. For this reason, small, reliable, low power storage devices such as recorders or magnetic elements with high capacity are being investigated.

TV data, such as image signals from a vidicon camera will be converted from analog form into digital form prior to storage, rather than after playback to avoid wow and flutter effects of tape recorder on picture.

For initial planetary missions involving pictures, video techniques are preferred over film techniques because the processes associated with retrieving film—using conventional emulsions, exposing processing and electronically scanning film—tends to make a more complicated and heavier system. Simple moderate performance vidicon systems can do a satisfactory job at sizable weight savings. When the weight price can be paid, the film system offers twin advantages of high resolution and high performance.

PROBLEMATICAL RECREATIONS 134

The family of a Quality Control Engineer consisted of 1 grandmother, 1 grandfather, 2 fathers, 2 mothers, 4 children, 3 grandchildren, 1 brother, 2 sisters, 2 sons, 2 daughters, 1 father-in-law, 1 mother-in-law, and 1 daughter-in-law. What is the smallest possible number of persons in his family? —*Contributed*

Smallness is a prime consideration in the design of inertial systems components at our Guidance and Control Systems Division where engineers experienced in sub-miniature electro-mechanical devices are invited to apply. The man to see is Mr. Don P. Krause. Or simply mail a resume. It will receive Mr. Krause's immediate attention.

ANSWER TO LAST WEEK'S PROBLEM: A triangle can be formed if and only if: (1) the breaks are on opposite sides of the midpoint of the Alpenstock (probability ½) and (2) the breaks are less than ½ an Alpenstock's distance apart (probability ½). The desired probability is therefore ¼.

start of the video input, a ramp voltage is applied to the differential amplifier so biased that the ramp lasts 64 microsec (Long enough for as many as 64 one-mc. clock pulses, representing a 6 bit capacity to reach the accumulator). When the voltage level of the ramp reaches the level of the video input, the differential amplifier senses this, closes the gate thereby giving the accumulator a binary representation (from 1 to 64) of the input waveform. Input is sampled in this fashion 400 times.

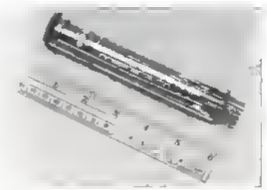
Programmer transfers the accumulation into the shift register from which it is shifted out in a six bit word. The encoder is integrated into the camera to provide some logic functions of the camera as well.

An effort is under way in-house to reduce the encoder size for ease of handling by the use of micro diodes in the programmer matrix and semiconductor microcircuits in five of seven flip flops of the programmer.

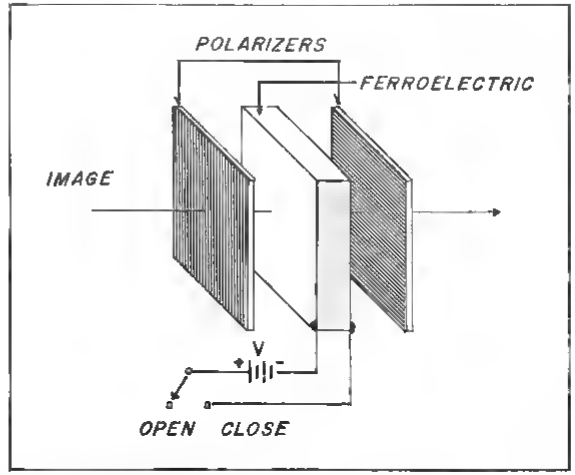
Recorders being developed for storing video data, according to Walter F. Brown, Jr., coordinator of Science Data Projects in the Space Science's Space Instrument Systems Section, include:

• **Digital Tape Transport**—This in-house development is concerned with a digital transport machine which moves tape in small increments and records one or a group of bits at a time. Perforated tape runs over a sprocket and so maintains good registry. The machine will play back in steps. A machine of this type avoids the need for synchronization as it would be needed in extracting bits of information from synchronous digital telemetry systems. The analog recorder, one that runs continuously rather than in discrete steps, normally requires either a buffer or a servo control loop to read out synchronously. The digital system would be using power only during record and playback. Continuously recording power is expected to be about 15 watts, record speed about 20 to 40 ips and any reduction speed for playback will be accommodated.

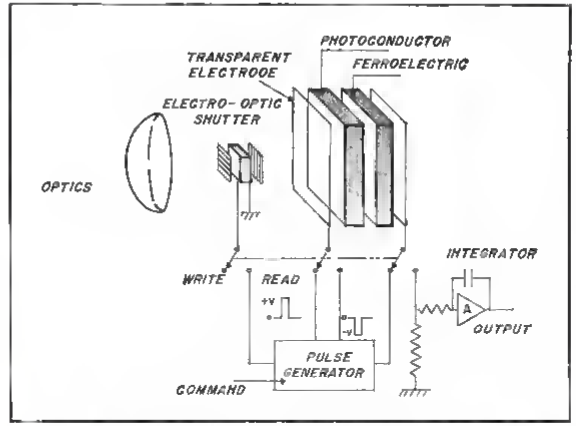
• **Kinelogic Machine**—Reel-to-reel recorder which has few moving parts and probably low wow and flutter, developed



VIDICON TUBE of the type that will be used in TV camera being developed at Jet Propulsion Laboratory for obtaining pictures of Mars surface.



DRAWING OF FERROELECTRIC SHUTTER for solid-state camera with Polaroid picture taken with shutter in open position.



FUNCTIONAL DRAWING of solid-state camera being developed by Electro Radiation uses photoconductive film as light sensing element and ferroelectric crystal as image storage medium. Electroluminescent mosaic will provide selectively controlled readout.

independently by Kinelogue Corp., Pasadena is being made for JPL. The machine will run about 10 to 12 lb. It has an unusually simple drive mechanism making it suitable for space missions.

• **Mariner B Recorder**—Functional design for this reel-to-reel machine having a capacity of 100 million bits, sufficient for 100 pictures at one million bits per frame, has been completed. The machine to be made by Raymond Engineering will have 3,000 ft of 1-in., 1-mil Mylar tape. Its reels will be mounted on a single shaft and may be capable of contrarotating so as not to create undesirable torques on the spacecraft. It will record at 20 to 40 ips., will weigh about 15 lb., require about 15 watts for record and has speed reductions of 100:1 to 400:1. Playback speed is about 0.02 sec. This machine is intended for recording TV, infrared, microwave and other data. A backup machine for recording TV only is being developed separately in JPL's Telecommunications Division.

• **Endless Tape Loop**—Similar to the type of machine used in the Tiros meteorological satellite this machine would store programs for a data system on 100 ft of ¼ in. tape. Its capacity is one million bits. Raymond Engineering is developing it for JPL.

In addition a reel-to-reel recorder made for the now defunct Mariner A is being used for in-house studies. This was not designed as a video storage machine, as taking TV pictures was not part of Mariner A's mission. The machine has one million bit capacity, a packing density of 1,070 bits/in. and 80 ft of tape that records at 10 ips. It weighs 7 lb and has a 4 lb magnetostrictive delay line as a buffer.

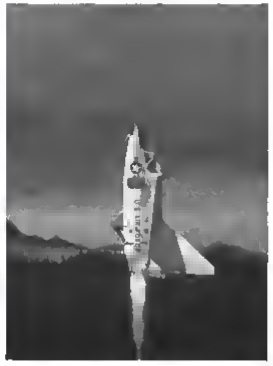
FILTER CENTER

▶ **Telstar Solar Cell Output Falls**—Power output from the solar cells aboard Bell Telephone Laboratory's Telstar satellite fell off 7½% from its initial value after the first month's operation but is not expected to drop below 66.7% of the initial value during the entire two-year calculated lifetime of the satellite.

▶ **Solar Cell Spheres Stymied**—Lack of economical methods of producing small uniformly shaped silicon spheres, two or three millimeters in diameter, has stymied further progress in developing one recent approach for boosting power output from solar cell converters (AW July 31, 1961, p. 72). Working under Signal Corps contract, Hoffman Electronics demonstrated feasibility of solar converter arrays using single crystal diffused spheres in three by four-inch arrays and achieved efficiencies for two-centimeter square arrays of between 8 and 10%. Advantage of this approach over conventional flat cells is that a converter with an array of spheres will catch more light than an equivalent sized flat cell array, consequently convert more solar into electrical energy.

▶ **Amateur Comsat Gets More Sophisticated**—Oscar 3, the third in the series of amateur satellites made by the Project Oscar Assn. affiliated with the American Radio Relay League, will carry a frequency translation type of communications repeater that will be capable of receiving signals at 144 mc and retransmitting them at 145.95 mc. The earlier Oscar satellites merely carried beacons which permitted radio amateurs throughout the world to track the small satellite. Oscar 3 is scheduled for a flight some time next year and the association hopes for a 300-mi. altitude.

TRI-SERVICE TILT-WING V/STOL TRANSPORT, *being built by Ryan (jointly with Vought and Hiller). Designed to transport troops, cargo and weapons, the VHR-447 will be produced to meet Army, Navy and Air Force logistical requirements*



RYAN X-13 VERTIJET, *world's first jet VTOL aircraft, was developed under Air Force and Navy contracts dating back to 1946. This was first aircraft to demonstrate the feasibility of vertical jet take-off with transition to level flight*

RYAN VZ-3RY VERTIPLANE, *a research aircraft designed, built and flown by Ryan for the U.S. Army and Office of Naval Research. It uses prop-jet engines and slipstream deflected by large wing flaps to achieve STOL take-off and landing.*

How to get maximum performance from V/STOL aircraft?

The Ryan V/STOL engineering team has the answer. With three million engineering manhours devoted to four vertical take-off research projects, Ryan is the world's most experienced and knowledgeable specialist in high speed V/STOL aircraft.

Newest and most advanced of these projects is the U.S. Army's VZ-11 research aircraft now being designed and built by Ryan. Powered by General Electric's lift-fan propulsion system, it will be capable of vertical take-off, yet cruise in normal flight at more than 500 mph. The VZ-11 concept provides maximum jet thrust augmentation for take-off *(engine thrust is multiplied 3 to 1 for vertical flight)*.

In many space age areas, flexible, fast-moving Ryan is making significant contributions. Ryan is the world's largest designer and producer of Doppler navigation systems and jet target drones. Among other Ryan activities are Flex Wing applications, electronics systems for lunar landings, and structures for space vehicles.

At Ryan Aerospace and Ryan Electronics, technical and management capabilities are designed to assure compliance with the most stringent standards.

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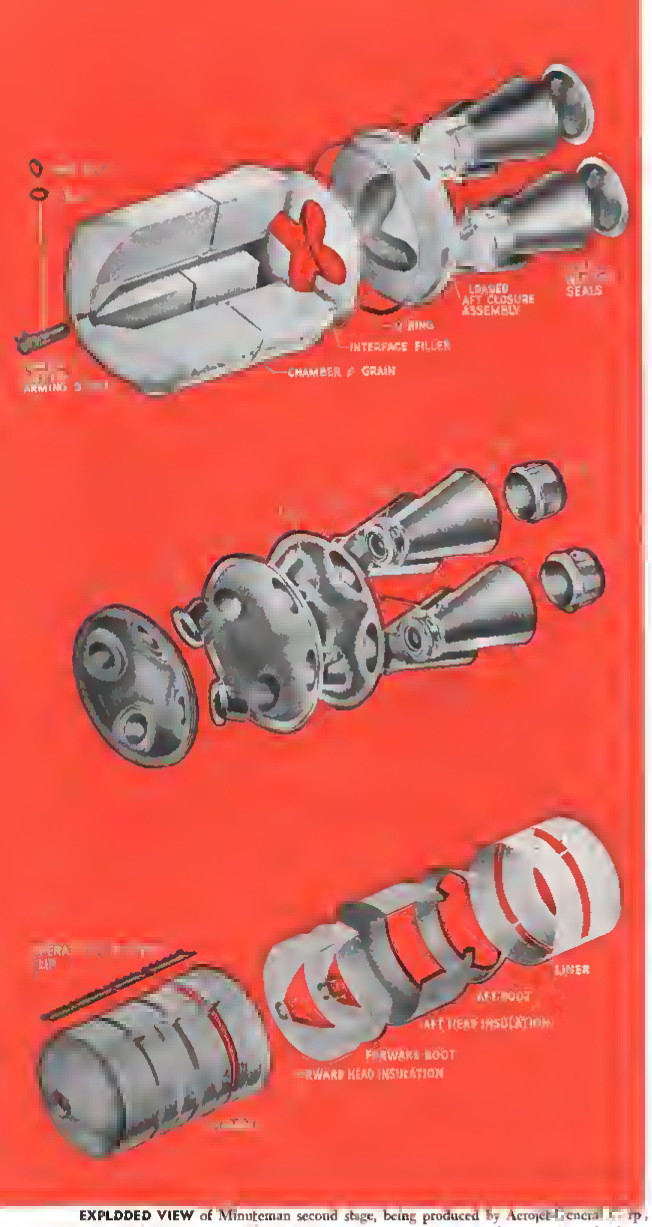


EXPLODED VIEW of Minuteman second stage, being produced by Aerojet-General Corp., shows major motor assemblies. Bipropellant system has outer and inner grain, the latter having a faster burn rate. Drawing does not show respective grain thicknesses, but only grain configuration at this particular cutaway section.

AerojetSecond Stage Must Withstand Heaviest Stresses

By Irving Stone

Sacramento, Calif.—Air Force Minuteman second stage motor, produced at Aerojet-General Corp.'s solid propellant rocket facility here, is adaptable dimensionally for glass filament-wound case construction, similar to Hercules Powder Co.'s smaller third stage, but this design approach was bypassed in favor of using steel.

The filament-wound case would have been as acceptable if it functioned only as a pressure vessel. But the second stage takes the brunt of the bending in the three-stage Minuteman configuration, and to obtain glass filament construction stiffness comparable to that required with the steel case would have made the case too heavy.

A major design refinement fed in by Aerojet for the second stage of the Minuteman Wing 2 modification of the intercontinental ballistic missile is an all-titanium motor case—6Al4V alloy—introducing a weight saving of approximately 220 lb. Nozzle refinements for the Wing 2 motor are reported to have afforded savings of about 25 lb. These are important design contributions since each pound saved gives one mile of range.

The titanium case design is based on an experimental stress analysis whereas steel case design for Minuteman Wing 1 was based on a theoretical stress analysis. Manufacturing techniques for the two types of cases are the same, but the cost of the titanium case is appreciably higher than the steel counterpart—reflected in both material and manufacturing costs—but the weight saved is considered to be worth the additional cost.

Second-stage rocket motor is built in company-funded facilities which assumed initial production status for Wing 1 motors last December. Unofficial estimates are that more than 200 motors have been processed since then. New company facilities are being built for production of Wing 2 motors.

For production control, all materials except propellant constituents for each motor are assembled in the form of a kit. The kit record shows where the part was built, what materials are involved, the inspector, and the method of inspection.

In the production process, all inert operations are performed off the propellant loading lines, so that the case is complete with all inert elements before the propellant is cast.

Minuteman second stage has a diameter of approximately 44 in. and is about 125 in. in length from forward dome to nozzle exit plane. Motor case is Ladish D6AC also used for Thiokol stage 1 (AW Aug. 27, p. 54). Developed originally as a forging die material and selected by Aerojet for its toughness, the alloy is a double vacuum-melted steel using the consumable electrode process. Chemistry is exact and steel is gas-free. In the several hundred cases supplied to Aerojet there never has been a failure. Aerojet says it has cut case costs by approximately 60% through refinement of the forging die, by application of hydrospinning and, most important, by using three suppliers for price competition.

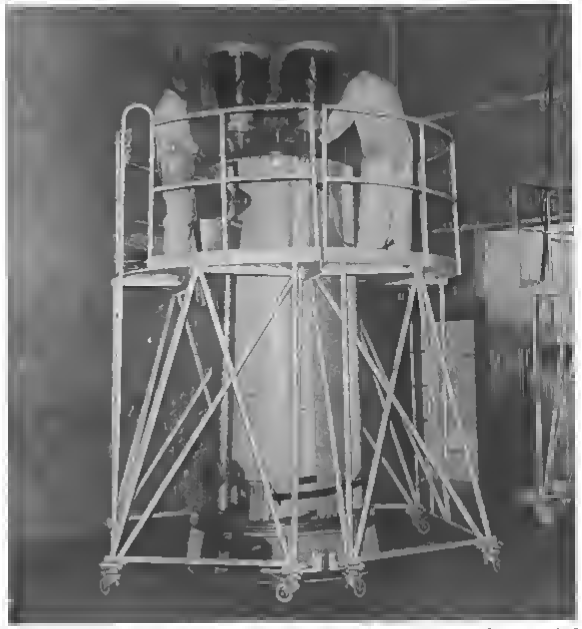
Cases are supplied by Avco's Lycoming Division, General Motors' Allison Division, and Aerojet-General's Downey Division. They also will supply Wing 2 cases. Case design breaks into four sections—forward head assembly, a center tube section, aft head assembly, and aft closure. The tube section is hydrospun and the forward head, aft head, and aft closure are made from closed die forgings. The two heads are joined to the tube section by girth welds.

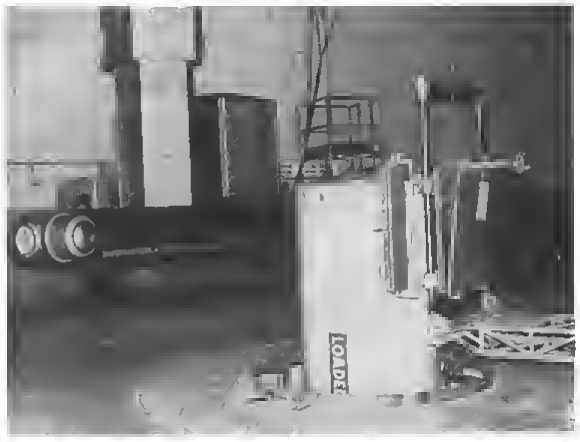
Aft closure is designed for bolting to the case. The case has integral skirts for attachment of the motor to the interstage structures on the Boeing assembly line at Air Force Plant 77, Hill AFB, Ogden, Utah. An operational raceway clip is attached to the case longitudinally to receive the electrical cable for nozzle control and other lines for research and development model circuitry.

On the inside, the case is insulated with a premolded, erosion-resistant rubber ¼ in. to 1 in. thick, with thickness increasing toward the aft end where the exhaust gas velocity is highest. Supplied by General Tire & Rubber Co. and Gaylock, this insulation is gage checked at Aerojet to ensure that it is within weight tolerance, and vulcanized to the inside of the case, using nitrogen as the pressurizing gas.

Avco's Avcote plastic insulation is sprayed on the external surface of the case in successive layers by an automatically traversing spray head until the proper thickness is built up. Thickness of the Avcote is varied to accommodate predicted heating loads along the case length.

For loading of propellant, the case is positioned vertically in a floor-pit vacuum bell which prevents introduction of contamination, moisture, air bubbles, etc., during the period when the propellant slurry is cast. There are 16 vacuum casting bells available for produc





AFT CLOSURE of the Aerojet second stage, complete with nozzle assembly, is attached (above) to the motor case in final assembly operation. Loaded second stage (below) is supported on elevator platform during radiographic inspection in pit.

tion, and this number will be boosted to 40 by late fall.

Second stage takes about 11 000 lb of propellant, mixed in a battery of five mixes in approximately 2,200 lb batches, and carried in propellant pots by cranes for feeding into the case in sequence.

Curing time for the cast propellant slurry is four to six days, with extent of the cure determined by sampling the hardness of the propellant.

Propellant is a class 2, polyurethane-type using ammonium perchlorate as the oxidizer. The polyurethane is fortified with an aluminum powder to increase specific impulse and control the burning rate. Propellant guaranteed life is three years, but indications are that life is substantially greater.

Propellant grain web thickness is about 19 in. and is made up as a bipropellant system having an outer grain and an inner grain, with the outer grain having the slower burning rate.

Purpose of the bipropellant system is to get a sliverless burnout coupled with a near-neutral pressure-time curve. It is desirable to obtain as short a duration as possible without exceeding the maximum thrust level specified. Burning for a longer period involves loss of range as a result of gravity loss. The closer the approach to a neutral pressure-time curve, the lower will be the gravity range loss. Combination of the fast and slow rates gives a cylindrical flame front for burning to a cylindrical, sliverless configuration. Other designs for sliverless propellant grain, Aerojet spokesmen declare, do not provide such a near-neutral pressure-time curve as obtained with this design.

Additional Cost

The bipropellant system involves additional cost as the result of dual-grain casting, but this is more than compensated for by the additional performance, Aerojet spokesmen claim.

Both grains have cross-configuration cores. The outer grain is cast first. The end of the grain is released, that is, separated, from the case insulation to permit the grain to accept changes in temperature without developing undue stresses. The mandrel for the outer grain is withdrawn and a second mandrel inserted for casting of the inner grain. After curing, the excess propellant in the aft end is trimmed.

The loaded rocket motor is moved to a radiographic facility where it is supported vertically on a platform which can be raised, lowered, or rotated as required for the inspection process. X-ray source is a 10 mev. Varian linear accelerator. An array of two 17 x 40 in. films is used with an overlap of 1 in. in the center, to give a 33 x 40 in. "billboard." Film also is used on either side of the 33 x 40 in. array for tangential exposure for inspection of the bond interface between the propellant and the chamber insulation—a critical area.

Six grain radial exposures are taken through each of four longitudinal sections. At each of these sections there are 12 exposures for the tangents. Six tangential exposures also are taken on the forward dome.

Each film panel is automatically processed from the raw film in about 13 min., dried and ready to be read. A single 17 x 40 in. film requires about 30 sec. to 1 min. for interpretation.

Specifications govern tolerances for deficiencies which may show in the propellant grain—discontinuities such as voids, cracks, porosity and fuel-rich areas, as well as bond deficiencies between propellant and chamber insulation. If a bond deficiency occurs in an area which may be reached prematurely by the flame front, the motor is rejected.

Blast Tubes

The four nozzle blast tubes in the aft closure are insulated with graphite backed by resin-impregnated glass filament to give the graphite hoop support. A rubber insulating sheet is vulcanized to the interior surface of the aft closure. A rubber insulation also is installed on the outside of the aft closure to protect against base heating, a condition which is aggravated at altitude with multiple nozzles.

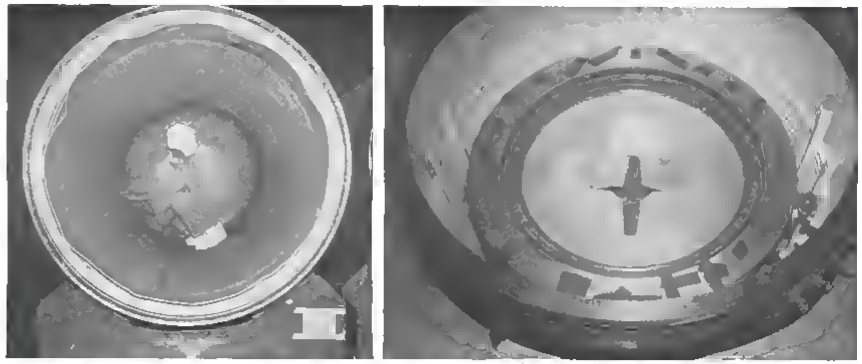
Nozzles furnished by Bendix, Straza Industries, or Aerojet's Downey Division are attached to the ends of the aft closure blast tubes and aligned optically. Nozzles pivot for a throw of about 6 deg.—perhaps 2 deg. less than on stage 1 and about 2 deg. more than on stage 3—and are paired for pitch, yaw, and roll control. Nozzle actuation is by hydraulic system similar to that used for stage 1 nozzle actuation.

Throat Liner

The nozzles have a tungsten throat liner supported in a graphite backing about one inch thick. The resin-impregnated plastic exit cone, which extends directly to the throat and affords an expansion ratio of about 18 to 1, utilizes a rubber seal system.

Propellant grain also is cast on the interior of the aft closure and serves the dual purpose of adding to aft closure insulation and contributing additional thrust. A lightweight sponge interface filler is inserted between the motor main grain and the aft closure grain to accommodate small dimensional deviations between the two parts.

Igniter is a small solid-propellant motor containing about 2 lb. of grain, essentially the same as the main grain. It extends about 18 in. into the motor



INTERIOR VIEW (left) of Aerojet second stage rocket motor shows premolded, erosion resistant rubber liner. In casting pit (right), core configuration of inner grain is shown. Black area in center is plastic sheet to close opening and keep core clean

and is equipped with a safing and arming device, standard for all three Minuteman stages developed by Bulova under Air Force contract.

In the transition from research and development to production status, Aerojet used a formal system of planning known as PRIMSCO—Pilot Run Item Master Schedule Committee. This master schedule was first used on Navy's Polaris stages built by Aerojet and results were so successful that it was applied to the Aerojet stage 2 in the Minuteman program. With modification it also will be used for Minuteman Wing 2 second stage work.

PRIMSCO chairman had responsibility for seeing that a total master plan and a detailed plan were established. Assisting the chairman were representatives from each functional area project engineering office, production control, manufacturing, quality control, facilities and also industrial engineering.

A master plan and schedule was created to outline everything necessary to produce the first unit, the pilot-run item. Each tool and piece of hardware or other material had its own schedule to establish milestone dates, which had to be met if the pilot item was to meet its schedule. The committee chairman obtained an individual signature for the assumption of responsibility for each milestone item. In its initial application to the Minuteman second stage program, PRIMSCO was instrumental in production of the first pilot item directly on schedule. Since then, items were ahead of schedule by as much as 30 days.

In its application to the Minuteman Wing 2 second stage, PRIMSCO is being modified by marrying it with PERT (Program Evaluation Review Technique) to display schedules in the form of PERT networks instead of milestone charts. The network shows the interdependence of the various events, which is not always shown on a milestone chart. Each one of the events has a number, and the line between events is called an activity line, which has an associated time period.

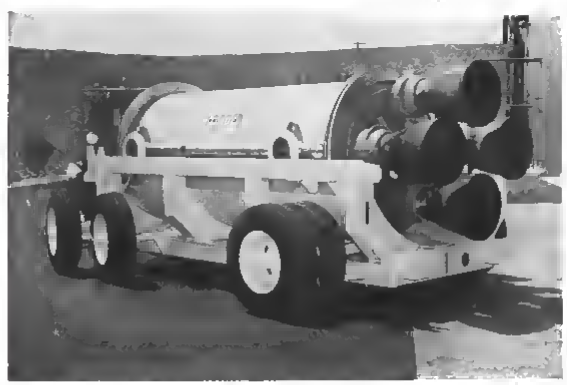
All information in the network is stored in a computer. So is the assignment of responsibility for each event in the network. Each two weeks, the computer examines the status of completion of the events, totaling about 2,600, in terms of the projected achievement of the pilot item target date. The computer also prints lists of personnel who have failed to accomplish objectives and addresses a memo to this effect to the program manager.

Approximately 2,450 employes now are engaged in Minuteman second stage research and development and production activities combined. This breaks down into about 800 shop personnel, 770 in engineering, 620 for support such as quality control, purchasing, etc., and 240 supervisors.

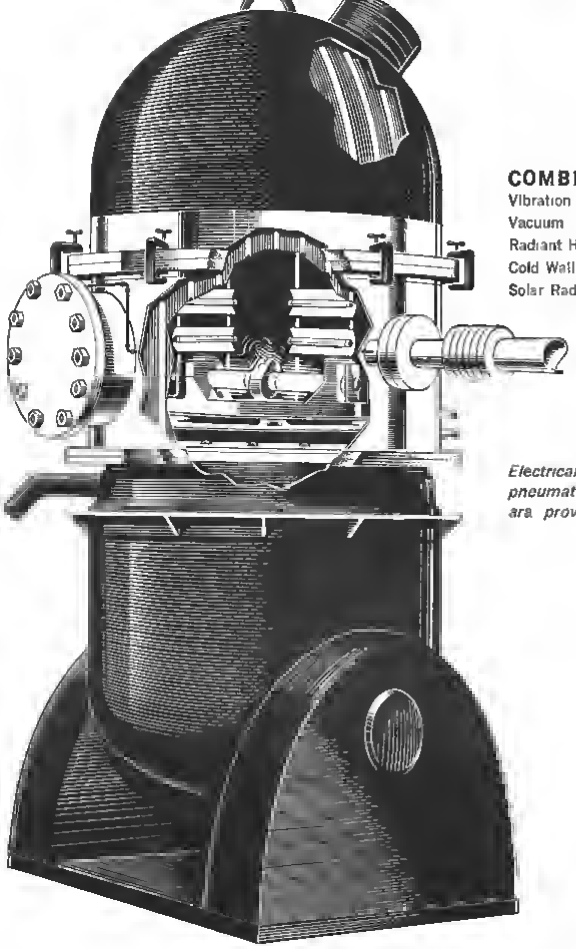
All vendor metal parts are purchased on a fixed-price basis. Metal parts supplied by Aerojet are on a cost-plus-incentive-fee basis, which is the nature of its contract for the second stage.

Aerojet went into production ahead of both Thiokol and Hercules Powder because its production facility, built with company funds, was ready earlier. Hercules and Thiokol built initial production units in their research and development facilities while awaiting completion of Air Force production plants.

(This is the second of three articles on design and production of the three rocket motor stages of Air Force's Minuteman ICBM. The third article, on the Hercules Powder Co. third stage, will appear in next week's issue.)



LOADED SECOND STAGE motor is transported from final assembly bay to shipping area at Aerojet's solid rocket plant near Sacramento, Calif. Stage is about 10½ ft. long and about 44 in. in diameter. Case weight will be cut 220 lb. with titanium.



COMBINED ENVIRONMENTS:

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Vacuum	1×10^{-8} MM Hg
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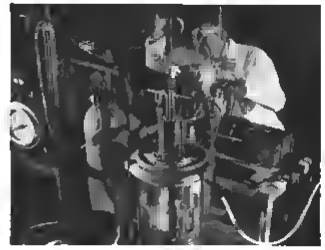

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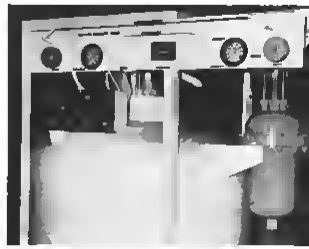

Auxiliary Powar . . .

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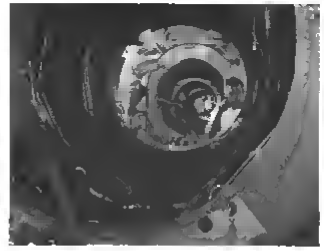

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PRODUCTION BRIEFING

Aeronca Mfg. Corp., Middletown, Ohio, will supply stainless steel honeycomb panels for the Apollo lunar mission spacecraft under a cost-plus-incentive-fee contract from North American Aviation Corp.'s Space and Information Systems Division. The panels, part of a substructure supporting the ablative heat shield material, are slated for delivery early next year.

Garrett Corp.'s AiResearch Phoenix Division will design, test and build 12-in. and 17-in. ball-type shut-off valves for the Saturn C-5 launch vehicle's RP-1 fueling and liquid oxygen systems under a contract from National Aeronautics and Space Administration's Marshall Space Flight Center.

Western Engineering Laboratories, a division of Melpar, Inc., Falls Church, Va., has received a $76,000 Army Signal Corps contract to develop a portable computer for use in detecting and locating the impact point of weapon or missile warheads.

Rocket Research Corp., Seattle, Wash., is designing a new internal combustion engine which will be driven by rocket propellants, under an Army Ordnance contract.

Bell Helicopter Co. Hurst, Texas, has been awarded a $3,285,000 letter contract from Air Force's Aeronautical Systems Division for the production of additional Army HU-1B Iroquois helicopters. The new contract brings Fiscal 1962 procurement to nearly $67 million.

Pfaudler Co., a division of Pfaudler-Permutit Corp., Rochester, N. Y., will conduct research in the field of high temperature, oxidation-resistant coatings for columbium, a refractory metal used in re-entry vehicles, under a $74,900 contract from Air Force Systems Command's Aeronautical Systems Division.

Republic Aviation Corp., Farmingdale, N. Y., has received two Federal Aviation Agency contracts totaling $228,430 to conduct research on high temperature hydraulic fluids and seals and sealants for use on supersonic transport aircraft.

Technical Operations Research Corp., Burlington, Mass., has been awarded a $700,000 contract, extending the OMEGA (Operations Model Evaluation Group Air Force) technical assistance program which it has been providing Air Force's Battle Analysis Division.

Six Airlines File CAB Reports on Salaries

Washington—Following are airline officers' salaries, bonuses and indirect compensation, expenses and stock holdings as reported to the CAB for the year ending Dec 31, 1961

Ellis Airlines—**B E Ellis,** president $10 800 salary $9 180 expenses, 21 201 shares of common stock **J L Sherman** vice president $13 800 salary $607 expenses 8 479 shares of common stock **G A Redding**, vice president, $15 840 salary $407 expenses 8 012 shares of common stock **N T Gerde** secretary and treasurer $17 008 salary $801 expenses 4 852 shares of common stock **J Fuok** director $10 200 salary $278 expenses 1 882 shares of common stock **E Hrath,** director $14 880 salary $51 expenses, 2 177 shares of common stock **B Nebetin,** director $8,400 salary $193 expenses, 030 shares of common stock

The following firm was paid $5,000 or more for services rendered during 1961 **Stump and Bailey** legal services $8 798

Ozark Air Lines Inc.—**F W Jones** chairman of the board $10 508 salary $1 125 bonus and indirect compensation, $2 021 expenses 311 886 shares of common stock **J H FitzGerald** president and director $25 200 salary $1 125 bonus and indirect compensation $3 033 expenses 11 440 shares of common stock **J P Bradshaw**, senior vice president legal counsel and director $11 329 bonus and indirect compensation (includes $10 208 legal fees) $1 507 expenses, 82 144 shares of common stock **E J Crane** vice president finance $10 503 salary $1 387 expenses, 404 shares of common stock **A G Bryur** secretary and director $10 208 salary $1 080 bonus and indirect compensation 52 000 shares of common stock **F H Green** treasurer and director, $10 208 salary $1 125 bonus and indirect compensation, $3 283 expenses, 53 248 shares of common stock, **B W Weaver,** director $1 125 bonus and indirect compensation, 3 184 shares of common stock **G O Shaver** director $23 647 salary (for flight captain duties) $1 155 bonus and indirect compensation $440 expenses 127 582 shares of common stock **C A Bachman** director $1 125 bonus and indirect compensation $1 070 expenses 15-548 shares of common stock

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Pacific Northern Airlines Inc.—**A G Woodley** president $35 000 salary $500 bonus and indirect compensation $8 288 expenses 214 123 shares of common stock **J A Cunningham** vice president $20 050 salary $500 bonus and indirect compensation, $830 expenses 1 900 shares of common stock **B A Olsen** vice president $19 374 salary $404 expenses, 8 065 shares of common stock **J B Fogler** vice president, $18 314 salary $103 expenses 1,000 shares of common stock **E Asharbon** vice president $15 185 salary $428 expenses 4 100 shares of common stock **T D Stuart** vice president, $13 808 salary $718 expenses, 1 700 shares of common stock **C W Nelson** secretary and treasurer $10 704 salary $500 bonus and indirect compensation $130 expenses, 1 100 shares of common stock **M F Diamond,** assistant secretary $10 630 salary 21 713 shares of common stock, **D B Bort** assistant secretary $12 278 $508 expenses 2 550 shares of common stock **G P O'Grady,** director $200 bonus and indirect compensation $2 252 expenses, 8 001 shares of common stock **R A Bowen** director $100 bonus and indirect compensation $188 expenses 14 000 shares of common stock, **M B Kirkpatrick,** director $500 bonus and indirect compensation 2 851 shares of common stock **F Ferrell,** director, 100 shares of common stock

The following firms were paid $5 000 or more for services rendered during 1961 **O'Grady and Marshall** legal services $34 565 **Botsford Constantine & Gardner** advertising $121 518 **Peat Marwick & Mitchell** audit fees $9 500 **Walter E Merkel & Assoc** public relations $7 730 **Tabulating Service Inc**, machine accounting $7 093

Kodiak Airways Inc—No officers listed at CAB as earning more than a $20 000 annual salary

The following firm was paid $5 000 or more for services rendered during 1961 **O'Grady & Marshall** legal services $6 034

Northern Consolidated Airlines Inc—**R I Petersen** president and general manager $25 000 salary $1 000 directors fee $3 510 expenses 219 220½ shares of common stock

The following firms were paid $5 000 or more for services rendered during 1961 **Price Waterhouse** audit fees, $7 174 **Theodore I Seamon** legal services $15 000

Southern Airways Inc—**F W Moise** president and director $25 000 salary $5-855 expenses, 40 300 shares of common stock 2 000 shares of common stock in the name of others $81 500 debentures **G Hall,** vice president-sales $18 500 salary $5 507 expenses, 400 shares of common stock, $300 debentures **W S Magill Jr** vice president-operations $18 875 salary $504 expenses 1 400 shares of common stock, $2 000 debentures **G F Exley** secretary and treasurer $12 000 salary $6 1 expenses 3 400 shares of common stock $7 400 debentures **C B D Tarver** assistant treasurer $11 750 salary $2 308 expenses 1 292 shares of common stock $2 700 debentures **J K Coakley** vice president administrative service (since Nov 1961) $9 167 salary $718 expenses 582 shares of common stock, $300 debentures **C F Allwood** assistant vice president $8 850 salary $2 330 expenses, 178 shares of common stock $700 debentures **G M Green** assistant vice president $11 300 salary $40 expenses 233 shares of common stock $500 debentures **W B Grubb** assistant vice president $11 350 salary $459 expenses 401 shares of common stock $1 600 debentures

C A Beasley assistant secretary and director $4 000 salary $47 expenses, 4 203 shares of common stock, $5 000 debentures **W B White Jr** assistant secretary and director $82 expenses 947 shares of common stock $3 100 debentures **I F Jones** vice president 2 107 shares of common stock **W H Smith** assistant vice president (since Aug 1961) $69 expenses 400 shares of common stock **J M Atkins** director $65 expenses 220 shares of common stock, $200 debentures **E U Brooke** director 1,000 shares of common stock in the name of others **A J Bruolel,** director $ 8 expenses, 2 500 shares of common stock $10 000 debentures **A F Irby Jr** director $132 expenses 3 700 shares of common stock **H P Jeharton** director $174 expenses 5 500 shares of common stock $1 000 debentures **G G Jordan** director $5 expenses 10 008 shares of common stock in the name of others **R F Orr** director $37 expenses 1 000 shares of common stock in the name of others, $700 debentures **F B Schar** director $141 expenses **E B Strohrne** director $39 expenses 1 400 shares of common stock **R B Wooten,** director $51 expenses, 9 200 shares of common stock $8 700 debentures **F B Harry,** director $93 expenses

The following firms were paid $5 000 or more for services rendered during 1961 **Kilpatrick, Ballard & Beasley** legal services $23 732 **Fisher & Phillips** legal services $10 810 **White Bradley Arant All & Rose** legal services, $33 448 **Ernst & Ernst** auditing and management consultation $21 107 **Alex Brown & Sons** commission on sale of debentures $50 000 **Harris & Weinstein Associates** advertising agency $75 00

Glass Fiber Case Development Expanding

By Donald E. Fink

New York—Future Air Force use of glass fiber-wound cases for solid propellant boosters in the 120-in.-dia. and 156-in.-dia. sizes may be more clearly defined within the next two weeks, following meetings at Aeronautical Systems Division's Manufacturing Technology Laboratory at Wright-Patterson AFB, Ohio.

The laboratory has sponsored development of glass fiber cases for Minuteman's first stage and will hold the meetings to discuss plans for expanding its program to include the larger cases.

Thiokol Chemical Corp.'s Wasatch Division was awarded a contract from ASD to fabricate and test two cases for the Minuteman program. Thiokol subcontracted the winding to Lamtex Industries, Inc., Farmingdale, N. Y. Lamtex delivered two 66-in.-dia. by 22-ft. cases that company officials said exceeded specifications. No additional funds have been made available, however, leaving the future of the program uncertain. It also may be resolved at the upcoming meetings.

Navy also has given impetus to their development by first using them in the upper stages of A-2 Polaris and now in both stages of the advanced A-3 Polaris (AW Aug. 13, p. 29).

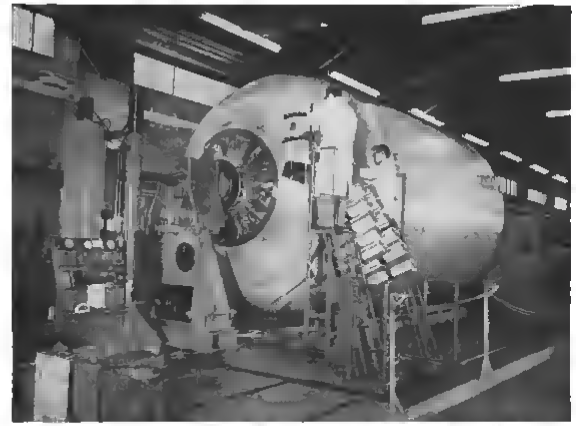
National Aeronautics and Space Administration's Marshall Space Flight Center prompted additional interest in glass fiber cases in May, when it issued requests for quotation for the design, fabrication and testing of a 156-in.-dia. case. The program later was suspended (AW Aug. 6, p. 23) following Air Force objections.

Hercules Powder Co., one of seven companies to bid on the NASA program at the time, had a company-funded 156-in.-dia. case in the final stages of winding at its Rocky Hill, N. J., plant. The case is now finished and will be used for demonstration purposes, since no funds for further development are in view.

Based on experience gained with the first case, however, Hercules is preparing an unsolicited proposal for funds, which it will submit to Air Force in the next few weeks. The request will be for funds to conduct advanced studies of winding techniques and for fabrication and testing of a second 156-in.-dia. case.

United Technology Corp., Sunnyvale, Calif., also is working on a 156-in.-dia. case, although it did not bid on the NASA program. UTC's case will be segmented rather than monolithic and is scheduled for completion by December. It also is being developed as a company-sponsored project, but Air Force is expected to be interested in it.

In all, approximately 25 companies are either fabricating filament wound cases or are developing winding facilities. Among these are Aerojet-General Corp., which has wound a 54-in.-dia. case on a vertical winding machine which can be expanded to handle greater diameters. General Motors Corp.'s Allison Division, which has wound 44-in.-dia. cases and has devel-



HERCULES POWDER CO. technicians adjust thread tension (above) on the winding machine as fabrication of the company's 156-in.-dia. glass fiber wound case nears completion. Monolithic case, 25 ft. 2½ in. long, was wound on a steet reinforced mandrel which had been covered with plaster. Final helical winds are added to case (below) which has wall thickness of 1.2 in. Pole pieces were wound into case with helical winds. Company financed case will be used for demonstration purposes, since no further development funds are in view.

AUTOMATIC RESIN BLENDER is used by Lamtex Industries, Inc., to maintain accurately compounded resin mixtures. Quality control during winding is essential to insure uniform wall strength. Lamtex has wound 66-in.-dia. cases under subcontract from Thiokol Chemical Corp.'s Wasatch Division.

oped an automatically controlled machine capable of winding 156-in.-dia. cases, Goodyear Aircraft Corp., which has wound cases the size of the first stage Polaris and reports being able to wind up to the 144-in.-dia., Lockheed Aircraft Corp.'s California Division, which has wound radar domes and is conducting advanced research in filament wound rocket cases, and Black, Sivalls & Bryson, which also has facilities capable of handling the 156-in.-dia. cases.

Winding Techniques

Basic winding techniques vary little among the companies. UTC's development of a glass fiber bonding technique, enabling it to construct a segmented instead of a monolithic case, is the only radical departure.

Fabrication of a filament-wound case begins with the construction of a mandrel, built to the inside dimensions of the rocket case. Solid plaster mandrels have been used for smaller cases, but larger ones require steel frame mandrels which are covered with plaster and templated to the desired dimensions and smoothness. The mandrel can be set either vertically or horizontally.

Filament winding directly on solid fuel segments also is being considered for the large solid-propellant boosters which probably will have to be wound near the launch sites, because of transportation difficulties. For the 260-in.-dia. feasibility motor (AW June 18, p. 31), Hercules has worked out a technique which could be used if glass fiber cases are included in the competition. They propose stacking segments of solid fuel on a nozzle assembly near the launch site and winding the glass fibers over the segments with a large vertical winding machine.

The 156-in. case Hercules developed was wound on a horizontal mandrel. With it, company officials said they hoped to prepare for the NASA 156-in. competition and also to work out fabrication problems they might encounter if filament-wound cases were included in the 260-in. competition.

Engineering for the 156-in. case was begun in February. An 18-in.-dia. steel tube was used as central shaft for the mandrel, which had 16 supporting frames attached to it. The 45,000-lb. mandrel was so finely balanced it could be turned by one man.

Layers of burlap and reinforcing wire were laid over the frames to form a rough surface for the plaster, which was put on in two layers, each 2 in. thick. Templates were used to form the rounded ends of the mandrel and to smooth the plaster for the inner case surface.

A dry pattern of glass threads, Owens-Corning Fiberglass ECG No. 140, was wound over the plaster to check the wind tension and put even stress on the mandrel. A ¼-in.-thick rubber sheet, which formed the case insulating layer, was laid over the dry wind and the resin-soaked winding was started.

Glass Threads

Glass threads, taken from a series of spools on the winding machine, were joined to form a 12-in.-wide band and were run through a resin reservoir. The winding machine, moving parallel to the axis of the revolving mandrel, spun the resin-impregnated bands onto it in looping helical winds.

End closures were made entirely by helical winds which were reversed around the pole fittings, retaining them under pressure. Circular windings were added to bring the hoop strength up to required limits, giving the case a wall thickness of 1.2 in.

The glass threads, soaked in a resin which cured at room temperature, required no heat treatment. Each layer bonded to the next, forming a solid shell.

To eliminate splices and insure uniform strength in each layer, the glass thread spools were replaced each time a layer was completed. In actual production, company officials say, the threads can be spliced without compromising strength. Any flaws that developed while a layer was being wound were removed by stripping the layer off before the resin set.

The finished case measures 25 ft. 2½ in. in length and weighs 21,000 lb. The pole pieces have an outside diameter of 7 ft. 2 in. and an inside diameter of 5 ft. The case was designed for 1,200 psi. minimum burst pressure, with a composite hoop stress of 85,000 psi.

A skirt was wound on one end of the case by attaching a wooden template and winding out over it. This was done to demonstrate the capability of winding skirts, doublers, fins and even screw attachments as integral parts of the case.

Since the case is to be demonstrated and not tested, Hercules officials will not have positive proof that it will withstand minimum burst pressures. If Air Force allocates funds for a second case, however, they intend to hydrostatically test it to destruction.

Hydrostatic testing is the only means of determining case strength, and since the case walls cannot be checked with magnetic flux techniques, some say the amount of fiber weakening cannot be determined. Tests with smaller cases, which ultimately were taken up to burst pressure or fired, have satisfied most filament winders that once specifications have been established, hydrostatic tests to 80% of anticipated peak pressure will prove the cases without excessive fiber weakening.

United Technology's current work with its 156-in. segmented case culminates two years of work to perfect a bonding technique. Their segments each will be 282 in. long and will be wound over collapsible mandrels. Each end of the segments will be reinforced with circular winds and then the segments will be trimmed to 276 in.

The upper and lower heads will be wound as one monolithic segment with round ends. It will be cut in two and the edges will be reinforced to catch loose ends. Each segment will be cured at 300F to improve shear strength.

UTC officials feel the segmented case will have several advantages over the monolithic case. The segments are easier to fabricate and handle, can be loaded and transported more easily and can be used to assemble boosters of varying lengths and capabilities.

Lamtex Cases

Lamtex's 66-in.-dia. cases were fabricated with a winding operation closely resembling that used by Hercules. The finished cases were shipped to Thiokol for hydrostatic testing and both were under the target weight of 1,983 lb., one weighing 1,949 lb. and the other 1,932 lb. Design specifications, calling for a burst pressure of 1,113 psi., also were reported bettered, with the first case tested withstanding 1,164 psi. before bursting.

Since no government funding is scheduled for the immediate future, companies not able to finance in-house development of large glass fiber cases are adopting a "wait-and-see" attitude. Most, however, feel glass cases have enough of a future to warrant conducting research programs to advance the state-of-the-art.

Advocates of glass cases say their advantages cannot long be ignored. L. B. Johnston, manager of Hercules' Rocky Hill plant, says the feasibility of glass fiber cases has been proven with the upper stages of Polaris and Minuteman. He added that his company's 156-in. case is a big step toward proving the feasibility of filament-winding for larger boosters.

Johnston said Hercules has extended its filament-winding research to include the 260-in. feasibility motor and can offer proposals for winding over the solid propellant segments near the launch site. The winding facility, he said, would cost about $1.5 million.

The development of glass fiber cases was described as "set against a background of debate between advocates of liquid and solid fuel boosters" by Edward J. Sheehy of Hercules' Ballistics Division. He said those in the solid field have sought ways to make the large solid propellant boosters more feasible and believe fabrication on site with larger vertical winding machines is the answer. (See Minuteman, Part 3, Sept. 10 issue.)

Slow Acceptance

The relative newness of glass fiber construction and unfavorable attitudes toward both solid boosters and glass fiber cases by high level decision makers also were listed as reasons for slow acceptance of the filament-winding technique.

On the positive side three major advantages of glass fiber fabrication over steel generally are put forward.

- **Strength to weight ratio**, rated at four times that of steel at the present state-of-the-art and improving rapidly as stronger glass fibers are developed.
- **Lower costs**, which in the Polaris case was listed as $10,000 for glass fiber as compared with $50,000 for steel and $100,000 for titanium.
- **Lead time** which can be reduced by two-thirds, because no excessive tooling is required with winding machines which can be expanded to accommodate a variety of propellant segment or mandrel sizes.

Chief disadvantages listed for glass fiber construction are the tendencies of glass fiber to buckle when subjected to unusual stresses such as those caused by rapid acceleration under heavy load conditions or by the twisting of ground handling difficulties in maintaining uniform strength because of thread breakage during winding and the lower heat resistance of glass fiber.

Charles O'Dell, head of the filament winding research department at Martin Co.'s Orlando, Fla. division, said the ground stress problem can easily be solved by developing different techniques for moving the rocket motors and for raising them to the vertical position. He discounted any in-flight stress problem, saying no flights now programed will produce stresses that cannot be met with glass fiber case strength.

Heat Resistance

Other manufacturers say that with proper insulation, glass fiber cases can be made as heat resistant as steel. Further, they say, thread breakage, not considered a problem by all is being corrected with the development of automatically controlled winding machines which maintain a more positive tension control. Splicing techniques also are improving as better resins and glass thread become available, enabling the filament winders to repair breaks and still maintain design strength.

Shear Spinning Used for Nose Cones

Aluminum nose cones for the Bullpup air-to-surface missile are produced by shear spinning at Avco Corp.'s Lycoming Division, Stratford, Conn. Lycoming, which produces the nose cones for Maxson Electronics of New York, fabricates them from hydroformed aluminum which is shear spun to thin-wall configuration.

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LETTERS

Fair Play

Let's be fair in our criticism of the FAA If anybody is chasing rainbows it's Mr M Short in his letter to the editor in your Aug 13 issue (p 130) regarding collision warning devices

In the first place all aircraft are not equipped with VHF radio, second, identification and isolation of replies was not even mentioned in his proposal and third, I doubt if the mounting brackets and interconnecting cables for any piece of electronic equipment can be installed for $150, not to mention the cost of the equipment itself

It is evident that criticism of the FAA in your magazine is in vogue, but, I reiterate let's be fair

HOWARD L McFANN
Pleasantville, N J

FAA Critic

It amuses me to read that the FAA Administrator should describe past FAA management as "not system oriented, poorly organized and badly managed" (AW Aug 13, p 39), when I see in the same copy of AW a conflict in FAA policy

The policy appears to be to reduce the number of Air Route Traffic Control Centers This will save $100 million and will increase safety

Yet the Minneapolis and Great Falls Air Route Traffic Control Centers will be broken up into four smaller areas, namely

1 The Minneapolis Center area
2 The Grand Forks SACE Direction Center area
3 The Minot SACE Direction Center area
4 The Great Falls SACE Direction Center area

(On p 45 reference is made to this but not in full)

Congressman Joseph E Karth (D-Minn) is now a leader in seeking the answers to this incongruity

(Name withheld by request.)

Patent Problem

I would like to take exception to Mr Crommett's use of the term "design engineers" (Letters, AW Aug 6, p 134) in place of the term "inventors or imagineers" as they are not the same This misinterpretation of the two is one of the prime mistakes made by many people, that is, assuming that every design engineer is an inventor (Ref Mr Jacobson's letter in AW April 30, p 98, the "third ingredient" in paragraph 5)

Most designers and engineers use existing techniques and hardware and arrange designs to use them to their advantage without "creating" any new concepts or devices It's true that these people are hired to engineer and occasionally one will come up with a patentable invention, but very few come up with a second invention These people are engineers and not "imagineers" and should be disregarded when talking about inventors

Mr Crommett is correct in saying that the inventor should be willing to pursue his ideas at his expense but many companies make this extremely difficult to do By this I mean that they will not grant releases when they are not interested in pursuing an invention, or they make it extremely troublesome by red tape or delaying action to secure Even when a release is granted it usually gives the parent company and its subsidiaries free use of the invention if and when the inventor does succeed in obtaining a patent at his expense without a penny of the company's money being risked

In view of these obstacles it's no wonder that companies have to resort to "bribery" in the way of cash awards to entice their employees to turn in inventive ideas (ref paragraph 9 of Mr Jacobson's letter) Until industrial management wakes up and uses more common sense in their patent policies and less legal red tape, the patent problem will always exist

ROY P GIBBENS
Orlando, Fla

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Airliner Museum

I am writing to you on behalf of the Society For the Preservation of Commercial Aircraft (SFPCA) to determine your interest in the preservation of historical commercial aircraft The members of SFPCA feel that the commercial airliner should take its place in history next to the locomotive and the automobile We are dedicated to the purpose of

1 Securing the necessary equipment for exhibition;

2 Establishing a site and building to exhibit this equipment on a permanent basis

The SFPCA is organized to represent those people who share the same interests in commercial aviation and is open to all persons who will strive to accomplish our goals Our main objective is to secure piston equipment which today is on the brink of extinction The opportunity to obtain such equipment is here now, and it is up to the SFPCA to establish a museum home to exhibit these historical items to the public

The museum would exhibit all aircraft and equipment which has been prominent in the development of commercial aviation It is expected that numerous items will have to be procured from public and private institutions by payment and donations The museum will have the sole purpose of acquainting and educating the public with the development and advantages of commercial aviation

At present, we hope to acquire modern piston equipment through donations by commercial airlines Today, there is an overabundance of piston equipment and a small market in which to sell it A letter is now in the hands of the U S Treasury Department requesting information about possible tax advantages to the donor of an aircraft or equipment for permanent exhibition Our present interpretation is that a corporation may deduct the market value of the equipment donated to a recognized non profit place of exhibition as long as the value does not exceed five per cent (5%) of the gross revenues of the company

We believe the location and acquisition of an acceptable site should rest with state and local governments civic and private interests Of course, it would be desirable to locate at an airport in order to provide the proper atmosphere and to save ground handling costs as well as breakdown costs which would be expensive if it were necessary to truck in the displays

The SFPCA is not financially equipped to undertake the costs of these proposals and is acting only as a coordinator for all interested parties Financial aid could be derived from federal, state and local governments, the airlines, ATA civic groups and private interests

To create as much enthusiasm as possible, letters have been sent to the 48 governors of the continental United States, the Senate Committee on Aviation, Federal Aviation Agency, Air Transport Assn the mayors of 15 metropolitan areas, and leading manufacturers of aircraft and aircraft components Our cause is being presented to local and national radio and television outlets, leading publications and to privately sponsored associations and interests

Gentlemen, this is a vast undertaking, but now is the opportunity to obtain the necessary land, buildings and equipment to achieve the goal that has been set forth Please talk over these proposals with your friends business associates and acquaintances Mention it to others who are involved in similar occupations as your own, and then write me expressing your views, opinions, suggestions and criticisms of our program Thank you

EUGENE W. LASSERS, Chairman
Society For the Preservation of Commercial Aircraft
405 Concord Way
Burlingame, Calif

Wrong Forging

In the Aug 6 edition of AW, on p. 73, there is a picture of a C-141 forging The description given just below this picture is of a different forging

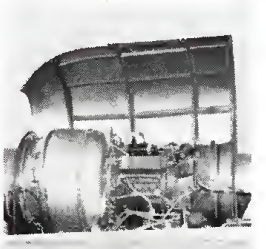
The forging shown is the upper quadrant It weighs approximately 557 lb with 1,815 sq in of size The forging you have described is the lower quadrant Take a look at the Wyman-Gordon ad in the July 30 AW, on p 4

HARRY LEDERMAN
Production Design Engineering
Lockheed Georgia
Marietta, Ga

(Mr Lederman is correct The forging shown on p 73 of the Aug 6 issue is the upper quadrant and does weigh 557 lb with a total area of 1,815 sq in; our description was for the lower quadrant — Ed)

Lycoming T53: aerial Jack-of-all-jobs

This is the versatile HUSKIE, the Kaman H-43B utility helicopter. It's a rugged, maneuverable aircraft, used by the Air Force for pickup and delivery of troops and cargo in rough country and at high altitudes. One reason for this Air Force helicopter's outstanding capabilities and performance is its Lycoming T53-L-1 gas turbine. It is compact and lightweight. Runs on many fuels. Provides high power per pound of weight. Operates dependably. And, because the entire power turbine and combustor removes as an assembly, the T53 is easy to maintain. The T53 is one of Lycoming's growing family of turbines with ratings up to 2400 shp. Their applications in industry and for the military are limitless.



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